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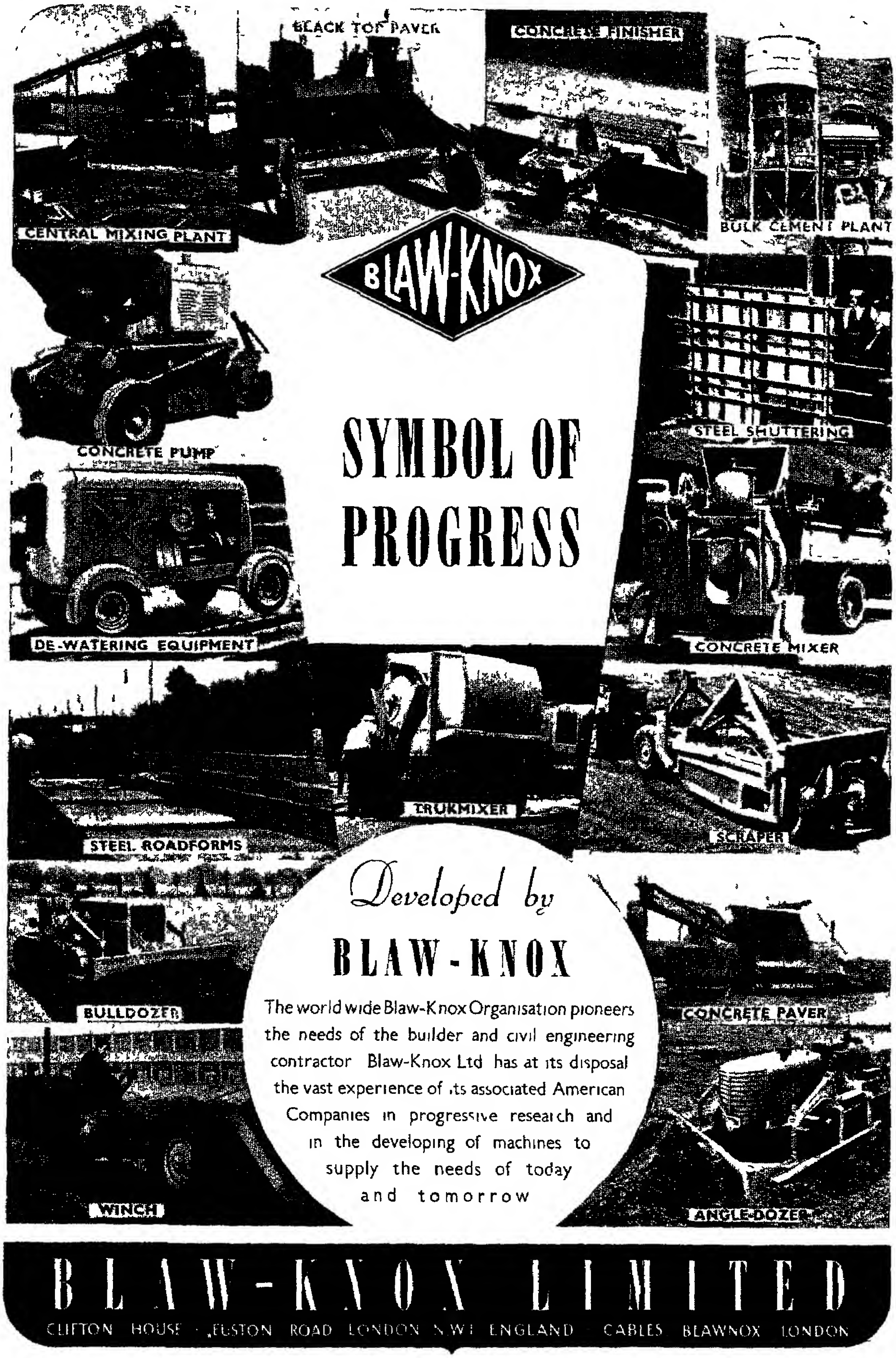
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The INDIAN CONCRETE JOURNAL

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EDITORIAL NEWS & NOTES

HEALTH AND ROADS

The I R T D A has sent the following memorandum to the Health Survey and Development Committee, stressing the intimate connection between the means of communication and health development in this country

Civilization implies improved standards of living and health, better education and the substitution of science for superstition Without communications, civilisation cannot advance Health knowledge and health service cannot reach the people—Doctors cannot reach patients—Patients cannot get to Hospitals— Industrial workers cannot reach the countryside

The following analysis shows how roads are essential for advancing public health Malnutrition heads the list of India's ills and mention of it recurs again and again The only antidote is better nourishment

MALNUTRITION

Mainly due to
(1) Poverty
(2) Ignorance
(3) Physical obstacles to movement of food stuffs

It has been proved that Communications improve the economic condition of the country They carry intelligence Improved transport will provide, especially for industrial and urban areas nourishment now not properly available Prosperity and a more balanced diet are dependent upon adequate roads

MALARIA

Without doubt India's major public health problem

Roads will improve standards of malaria control

Preventive Ready access by skilled anti-malaria personnel improved drainage and vegetation control arising out of higher agricultural standards, adequate "quininisation"

Improved personal resistance due to the elimination of malnutrition mentioned above

Curative Ready contact with medical attention and drugs and prompt evacuation of cases to hospital treatment

INFANT MORTALITY & MOTHER CARE

1939- Infant mortality 156 per 1,000 live births Deaths from child birth during the same year—roughly 200 000

Communications by bringing education and knowledge will speed the elimination of superstition Ante natal and post-natal care will be more readily available for the mother

Hospitals will be within reach for the difficult cases Improved diet will increase the chances of survival of the infant

EPIDEMICS

Epidemics sweep away tens of thousands of lives annually

Prompt and energetic curative and preventive treatment is the only way to stifle an outbreak of epidemic disease This means rushing the necessary staff and equipment to the scene, which postulates adequate and speedy means of transport Neither exists where there are no roads

Improved knowledge of hygiene will reduce the incidence of epidemics and improved personal resistance due to improved nutrition will reduce death rates

TUBERCULOSIS

Greatest incidence in urban areas Total recorded deaths in 1939 65 586

This scourge preys upon the undernourished but apart from contributing to an improved diet, adequate communications would reduce over crowding in urban areas and would enable industrial and city workers to get to the countryside more frequently than they do

Dust, which can be practically eliminated by modern road surfaces is a contributory factor to this disease

SANITATION AND HYGIENE

Axiomatic that improved transport would facilitate necessary developments in sanitary services, increased knowledge would encourage improved standards of hygiene

MEDICAL SERVICES

The greatest obstacle to improved medical services in country districts is the absence of Communications Doctors cannot cover enough territory under present conditions to make a practice pay properly Rural situations are so remote from all the amenities to which an up to date young doctor and his family are accustomed that, even if a living could be made the extreme isolation of his situation often drives him back to the town Roads are the only solution to this twofold problem of

(a) the doctor reaching the patient and *vice versa* and
(b) the doctor retaining sufficient touch with the outside world to make his practice anything but immolation not only for him self but for his wife and family

VETERINARY SERVICES
AGRICULTURAL SERVICES

These two services have a direct connection with the diet and health of the nation At the moment their efforts are circumscribed by the difficulty of reaching the countryside owing to the absence of roads

HOLIDAYS FOR URBAN AND INDUSTRIAL WORKERS

The necessity for adequate holidays and change of scene for urban and industrial workers has been recognised everywhere, but it is not often appreciated how considerations of transport in India limit

(a) The frequency with which workers can take holidays in their country"
(b) The opportunities for a "run in the country which means so much to the town dweller in other parts of the world

The benefits of the lowly bicycle should not be overlooked in considering this question of roads and holidays and health

Note —All figures given relate to British India only

The 'Leader', Allahabad, in its issue of the 22nd Nov 1944 in commenting on the above and stressing the value of publicity given to the facts as shown says *"All this proves that no scheme of national reconstruction can yield the desired results unless the development of communications occupies a portion of high priority in it"*

'THE ARCHITECT'S SPHERE IN TOWN PLANNING'

A talk given by Mr. CLAUDE BATLEY, A.R.I.B.A., F.I.I.A., to the Institution of Engineers (India), Bombay Centre, on 25th October, 1944.

I WILL start my talk this evening with a quotation from a very thought-provoking book which I hope you will all read—Sigfried Giedion's—*Space time and architecture*—published by The Oxford University Press in 1943 —

" A good share of the misfortune of the last century came out of its belief that industry and technique had only a functional import with no emotional content

" To bring this fact in consciousness to try and overcome it, is closely connected with the outstanding task of our periods, to humanise—that is to re-absorb emotionally—what has been created by the spirit All the talk about organising and planning is vain when it is not possible to create again the whole man unfractured in his methods of thinking and feeling '

To a great extent that is the " Architect's sphere " in Town Planning as well as in building—' thinking ' may plan a " safety-first ' town from a traffic or even, a material—health point of view but, only, " feeling ' can humanise it

Among other things the Architect must act as the ' sky-pilot ' of the building brotherhood of Town Planners

It is he who must be the pointer to clearer and higher ' thinking and feeling " In tackling every one of the problems, from the planning of a cottage to that of a mansion a block of tenements or of flats to that of a large municipal building or a governmental office it is the Architect's province to consider aspect and location, to analyse or zone to associate or dissociate factors according to their relative importance and ' user ', to study communication and intercommunication between departments or suites and finally, to make the whole problem by the study of scale and functional significance into a unified whole Therefore I venture to assert that, both by training and by practice it comes natural for him to enlarge his purview to the treatment of regional planning to new town lay-outs and to, even, greater schemes, dealing with the inter-relation of district and district and as days go by, to problems of interconnection of country to country, until, ultimately with complete internationalism, town-planning will become world-planning under an international comity of nations organised for the service of Humanity with a capital " H " Even so those primary principles, which planning teaches an architect, still prevail For this the need is not for a " robot-frankenstein-monstermind," in which the efficiency of the machine becomes man's master but organisation that shall equally satisfy the complete man together with that inmost yearning for " feeling," as apart from " thinking, ' call it " soul " or " religion," " art " or " beauty," it matters little as long as the inmost consciousness of each one of us, in our quieter moments, testifies that the urge for something of the sort is there, however suppressed, either by self-conscious restraint or by the distractions of our environment

Such a return, from mere invention for the sake of material production, towards the wider horizons which our nature calls for, must needs alter our view-point on many town-planning problems

The prospects of speedier transport, the carrying of the primary factors of water, light, power and fuel, more easily over vaster distribution areas, the revolution in modern ideas of communal securities, tend to practically revolutionise our ideas in regard to the very existence and purpose of towns and cities, as such

The original function of the town as a defensive co operative unit is fading very quickly For generations we have seen signs of its break-up—for instance, when old Ambar came down to new Jaipur, or when the defences of Bombay Fort disappeared to remain as street names only, Bastion Road, Rampart Row, Gunbow Street, Marine Lines Lanes, Picket Road, Church Gate, Bazar Gate and so on , it is going today, with the pulling down of the Ahmedabad city walls and their conversion into widened traffic-arteries, letting God's good fresh air into, instead keeping it out of, the City limits

In the old days the donkey, bullock and camel pack-animal, or even the hand cart, were the gauge for the width of the streets and the very slowness of such traffic necessitated the restriction of the city's size and led to its congestion

During the onslaught of the industrial revolution, it was natural to try and place the new railway station near the centre of the city, to place the factories as near to it and the docks as possible and the workers in those factories near their working places

Never mind, if it meant their living on half reclaimed marsh land or being packed into cheerless tenements with high flights of stairs to climb at the end of their arduous day's work Only the rich could afford to spend a little time on a somewhat longer journey to and from the pleasanter surroundings on the Western outskirts of the town and, thus, confusion and congestion grew a pace and ultimately resulted in such an upside down world that the working class neighbourhoods became the highest in land value and rents soared in exactly the reverse proportion to the ability of the inhabitants of any particular neighbourhood to pay them One roomed tenements, chawls and back to back rows of mean little houses resulted not in Bombay or India only, but throughout the industrialised world

Nowadays, conditions have so changed that, with the possibilities of fast transport, by buses, trams, electrically driven suburban trains either on the surface, above it on elevated gantreys or in tubular railways below it, distance has been, to a vast extent, eliminated by speed and, from an economic point of view alone, it is often wiser to establish factories and their labour colonies, replanned on modern lines, somewhat more reminiscent of their mulak-villages but idealised, with healthier surroundings with satellite settlements just off the main arterial roads or railways with green belts of agricultural land between them and the old city, where fresh vegetables can grow and cows may graze , and, if I can foresee any tendency at all, it will be more and more on some such lines

The congested, ill placed, obsolete factories, with their surrounding work-peoples' slums, will be demolished and their sites will become ample parking spaces and restful gardens, for the benefit of the few who must needs still live in the town for commercial or business reasons, the middle man, the trader and the professional Some of these abandoned sites will provide playing-fields for the secondary schools and the universities, some will afford sites for libraries, art galleries and museums, which must naturally arise with the increased cultural demands of a people living under improved conditions Mean dwellings and streets encourage mean outlook on life while the reverse conditions encourage a wider and higher cultural outlook

The towns will become, more and more,

Civic centres—
Professional centres—
Trade-control centres—
Co-operative shopping or Marketing centres—
Amusement and recreational centres—

To them the surrounding satellite village-workers and their farmer neighbours can resort, during their increased leisure hours, by the quick suburban transport services aforesaid

The sites of these smaller satellite-settlements can be selected for their pleasant environment, often on the lower slopes of hilly ground, leaving the lower grounds for the cultivators, for whom they are better suited The drainage of these satellite villages will then be a simpler

problem and will help to solve the problem of irrigating the neighbouring green-belt cultivated-area and keeping its soil properly fertilized

Another advantage of this industrial exodus from the towns will be the relief of traffic congestion and the elimination of the present ever-recurring problem of the expensive process of widening existing streets

Whenever a building, through old age or fire or other cause, has to be demolished, it should be the subject of an inquest, or enquiry as to whether its site could not better be utilized for some public purpose, for instance, if it adjoined a temple, a musjid or a public building or a school whether it would not be better used as a garden or a playground And not until such public enquiry has been concluded, should the private owner be allowed to resume possession

Such matters would I consider, be better settled by a kind of unofficial jury, consisting of non-official citizens, representing perhaps, such bodies as architects, artists, and educationists, in their corporate rather than their individual capacity, with no commercial axes to grind and with their broader-based outlook To guide them, a careful census of all the interesting buildings in the city should be prepared and kept up to date including the birth places and residences of notable citizens who have contributed to the city s real welfare and brought credit to its traditions

And when I speak of "interesting buildings" I would not confine myself to those illustrating or continuing, the fine old building traditions of the city or district but any fine modern buildings, which have received the general commendation of competent judges of such things for I visualize in my post-war planning, a general increase in the individual citizen's appreciation of what is going on in his city, including the public acknowledgment of any outstandingly successfully designed buildings and a graded remission of the general tax on those buildings contributing to the city s adornment and, on the other hand, a super-tax on any structure whose design or dilapidation detracts from the attractiveness of or, even disgraces, its neighbourhood In this way we shall find a marked decrease in the present indifference exhibited by house-owners and their tenants, in the property they own or occupy and a corresponding increase in good citizenship and the growth of a civic-sense This might soon lead to some discrimination as to what sort of men and women were selected and elected to represent them, and a severer public scrutiny of the motives and results that underlay and eventuated from their conduct of the public affairs of the city

Arising out of this subject a like revolutionary change must take place in the average citizen's reaction to rates and taxes They must not be regarded any longer as impositions, almost as communal fines and penalties, but as contributions for services which can be so much more economically rendered communally than individually

Fancy the enormously increased expense and the awful chaos that would result if each of us had, every day, to remove his own excreta, to fetch his own water, to pave, light and clean his own bit of street We have enjoyed these primary services so long now as to, almost, accept them as gifts from Providence but to the people in many European and other war devastated cities the consequence of the break-down of such facilities must have brought home to them their inestimable value

It will not be long, I think, before such services are greatly extended I look forward to the day when not only water, drainage light and power but, also, air-conditioning (either for warming or cooling) vacuum-cleaning and a great measure of communal bathing, dhobying, cooking and of creche-service will be provided on somewhat similar lines and so leave us and our wives free to do our own work the more efficiently in the house, the office, the shop or the factory and at the same time to have more time to keep our bodies fit by recreation and our minds fit by cultural pursuits

How tragically ridiculous it really is, for each little house-wife to have to bargain each day for her tiny scraps of household provisions, to take them home and, in many cases, spoil them still further by her amateur cooking, under almost impossible conditions over her own little chula, with her own little, relatively costly, quota of fuel and, at the same time attempt to undertake the specialist duties of nurse, often in the dark and totally inadequate surroundings of a single room tenement

And yet, with a little foresight and adjustment of prejudices, clubs could be designed, with specialist services by a properly trained personnel to do all this economically and efficiently, each for its reasonably small community a new form of joint family, but this time voluntary and terminable! Far wealthier communities have tried out such schemes, in their residential clubs, hotels, service flats and found that services, which they could never have hoped to enjoy as individuals, were at their disposal on very reasonable co operative terms Among the lower paid working-classes, the advantages would be even more advantageous

I well remember, in my young days when the train neared almost any large middle class town watching from its windows, the innumerable little oblong patches of back-garden each perhaps, about 40' × 80 feet in extent and surrounded each by its own little brick walls dividing it from its next door neighbours Some such little patches were bravely tended and gay with flowers but many were woefully neglected, untidy little jungles of junk with, perhaps a rabbit-hutch or a hen-house in one corner and, almost always, with the house-hold linen hanging on the line trying to get dry but getting smuttier and smuttier, from the smuts of passing trains and of the hundreds of little chimneys of the little kitchens, in which overworked house-wives were, each, trying to cook the family meals Now that phase has to some extent become obsolete and joint gardens, restaurants and properly equipped laundries and drying rooms have to some extent, taken their place

As I am speaking to the Bombay Centre of your Institution I think I can best drive home what is in my mind by a few home truths culled from local conditions and instances with which we are most familiar

Even in my time in Bombay I have seen the growing appreciation of the public garden, play-ground and promenade and I am convinced that more and more people will realise the growing potentialities of the other communal services I have mentioned

One of the most striking examples is the rise of the Indian cinema What an enormous influence for mass education, which is so different from mass literacy the film and the wireless might together, exert if only the right people put their heads and their hearts together to will it so

We often hear the Back Bay reclamation referred to as Lloyd s folly but have we yet realised the proper scheme of assessing such undertakings Living on Marine Drive I glory in the advantage taken of that sea-lung by all sorts and conditions of Bombay s population I know friends, living in the crowded bazaar and congested areas of the city, who make pilgrimages there by tram and bus, taxi and car in order to gain all that wide horizons give in physical and mental refreshment, I reckon that, most days 25,000 people enjoy such relaxation Put it at, only, 2 annas a head and it represents an asset to the amenities of the city of some ten lacs a year

Go and see the appreciation of that not-too well-run pleasure garden, Victoria Garden, and, again, assess its monetary value in the enjoyment it provides for its lowly visitors and their children Add the quotas of the various Maidans, of the Cricket Stadium and the University Garden and you will realise the "worth-while ness" of multiplying such wealth-making because health-making, assets in our city s more congested parts

The Municipality s Engineering Department is hard at work now, trying to get a decent regional-lay-out for the few acres of blast desolated-area, to the West of the Railway and just East of Mohamed Ali Road, which was swept, almost clear, by the occurrences of 14 [-44 But why not turn these acres into a little ' garden of memory ' to those who lost their lives in the disaster and to the good God who prevented the usual wind arising on those few nights and sweeping the fire through a much vaster area of the most densely populated areas of our City ?

Government has borne a considerable share of the loss to the structures themselves and our City Fathers should certainly not grudge the God-given opportunity to purchase the bare land, on our behalf, and turn it into a veritable children's paradise, just exactly where such an area is so sorely needed

A tithe of the black-marketer's illgotten gains, given as ' conscience-money " and "no questions asked" would do it and bring health and happiness to thousands of the relatives of the victims and their neighbours

What has all this to do with the Architect's sphere in town-planning? From my view point a very great deal, for until we bring the possibilities of their sharing the delights of fresh air and healthy surroundings, and the feeling that they have a personal share in that achievement vividly before the men and women in our streets, they will naturally, be indifferent as to whom they send to represent them on the Corporation, or in the Legislatures and men with vested interests of their own often exploiters of the very people they represent will predominate, in those Councils men with a vision limited by their money bags and their anxiety to keep those bags full

True, the most precious gifts of heaven are free, the sky in all its passing moods throughout the twenty-four hours, the good earth with its natural dress of grass and flowers and trees still waters and the everlasting hills but remember also, that the biggest effort Bombay ever made on behalf of its masses was the B D D chawls from which every one of these natural gifts of God were blotted completely out by concrete louvres I often wonder whether the B D D stood for "Bombay's Damned Disgrace or to put it more mildly, Bloody Dark Dwellings'

Thank God no architect had a finger in that pie

Lack of vision has given us a Marine Drive about two miles long with just two miles of monotonous fronts overlooking little but the glaring sea

The opportunity that Marine Drive presented has been ruined for ever those two miles of frontage to the sea might have been converted into at least six miles of more interesting outlook by setting back the central blocks between each alternate cross road and laying-out these open spaces as children's lawns and old peoples gardens and the whole result would have given scale and dignity to what might and should have been the finest promenade in the world

Now, alas all we can do is to wait for nature to bring its tons of monsoon sand each year until we have a wide expanse of clean sea beach stretching from Chowpatty to Colaba where children can build their sand-castles, while their grown-ups build their own castles in the-air or, drunk with nothing stronger than ozone, take an adventurous journey into happy dream land

The vast area behind this monotonous frontage has been ruled off into small rectangular plots which, if and when developed (what a term) will give us such an infamous monotony and congestion as I sincerely believe, will result in all but the most brazen of the inhabitants of those blocks suffering so chronically from ' claustro phobia ' that they will either be driven to suicide or accept such a dreary view of life as to cripple the whole of their business-outlook and thus do much to stunt Bombay's growth as either a commercially, or, culturally progressive city for many a generation

Thank God that the war has given pause to this catastrophe

The only way to mend it, just a little, even now, would be to make each alternative cross road a service passage, with gardens, either public or private, on each side of it and to set back the buildings themselves on the other cross roads, at least 50 feet from the road line If the short sighted pundits raise hell, then let these inland houses go up to a hundred feet height, so that some of their upper flats can also share some glimpse of the sea and let's do away with the too numerous and useless gaps at their sides I will guarantee, ultimately, a more remunerative return and a healthier, more progressively minded population, which is far more worth while, in the long run.

I wish I could persuade Engineers that the ideal road is not a long straight one and that, if any such roads are considered essential, they require the most careful consideration to avoid monotony They are the most tiring of all roads for pedestrians and are apt to encourage undue "speeding and a false sense of security among drivers—especially, if the numerous cross roads, which the ordinary Engineer appears to be so fond of, are persisted in Each of these latter is a veritable traffic-death trap and more than half of them are generally unessential, if you are thinking of the convenience of pedestrians, which is unusual, shaded crosslanes for them only, can be provided instead of each alternate cross-road

If you are still keeping the pedestrian in mind, let us provide more comfort-stations," each of them including free dressing washing rooms and cool-filtered drinking water

Moreover every long straight road must have "focal points' of interest, properly designed to form attractive stages to mark the pedestrian's and driver's progress along it Traffic islands and round abouts can afford such points of interest and I would confine the roadside-trees mostly to such little oases, which would, also make grand sites for statuary, with resting places and little flower-gardens around

In the busier commercial parts of the city they could form shelters for hawkers who instead of cluttering up our pavements, could ply their trade there What with this fraternity and the shopkeepers themselves pillar boxes, direction posts and utility-standards trespassing on the pedestrians own domain he, poor devil, (and I am one) is often driven on to the road to be dubbed a "jay walker" The edges of our pavements where not so obstructed are often overhung by the protruding ' backsides ' of motor cars, in a most disgustingly rude manner and, if I were dictator I would certainly, devise, and enforce the use of something to prevent such liberties being taken with our footpaths which are, anyway, of extremely inadequate width as it is

Now we are on such details, why have such a number of posts, etc, cluttering up our pavements?

The dangers at night are the curbs and little low standards along the pavements and around traffic round abouts and island refuges Then why not have these features properly illuminated, instead of ineffective over-head lighting, casting all sorts of confusing shadows If swimming baths can be illuminated by underwater "flood" and "spot" lights, there is no practical objection to my suggestion and the modern developments in luminous paint lighting and the various forms of toughened glass cubes and bricks and the development of "plastics" bring it well within the realms of practicability Street numbers and names could easily be incorporated in such schemes of lighting

The ' Architect's sphere" also, includes the exertion of all the influence he can bring to bear on banishing advertisements and uncontrolled sign-boards which deface, if they do not entirely conceal, our arhitectural efforts to beautify our streets It is, often, almost as difficult to find the street name, or house number, as to find the name of a railway station from the railway carriage

If you don't know what soap, or lip stick, to use nor where to get it, why not have a few exchange-bureaux, where enquiries can be easily made and the inside of whose walls can be plastered thick with posters and pictures for the benefit of those who care for such things At present, the advertisers object seems to make all sensible people boil with anger and resentment at advertisements glaring, even from our most beautiful mountain-scenery or desecrating the walls around our burial-grounds and burning-ghats

It is all just as wrath-provoking and peace-disturbing as to see our fountains without water and our temples and mosques without gardens and our schools without playgrounds

On the other hand there are still useless railings around our statues and our public gardens We have stacks of unnecessary ventilating pipes around our buildings, that could far more sensibly and economically be collected into one more central and effective, outlet We have thousands of rusting, leaking, overhead tanks and millions of ' Waste preventing cisterns,' the only explanation for which appears to be a secret conspiracy between the Hydraulic Department and the Licensed Plumbers

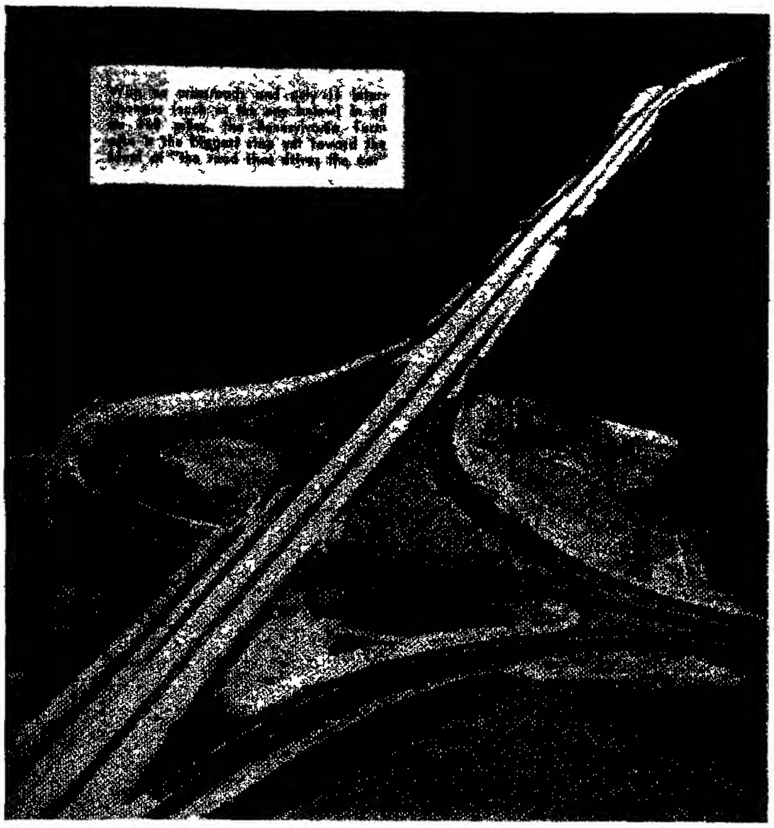
I would certainly institute a heavy tax on every soil or ventilating pipe and on every overhead iron tank or ladder that I could catch sight of from any public place or street, throughout the city, and I would spend the proceeds on increasing the Municipal water-pressure, so that all these features might the more quickly become obsolete and so save the citizens thousands of rupees and the Municipality millions of gallons, each year

The last time I spoke in this strain was about a quarter-of-a-century ago and it has taken almost, that time to introduce a few traffic round-abouts, in the most important centres in which I then suggested they were essential, meanwhile, too, a few statues have been erected without the senseless iron railings destroying their "intimacy" I suppose, may be in another quarter-of-a-century, a few of my tonight's suggestions may, possibly be adopted, God willing If so, this discourse, also, will not have been altogether in vain

YOU'LL LIKE THE ROAD AHEAD

Say goodbye to traffic jams, red lights, and highway hazards. After the war you'll skim cross-country on supersafe speedways.

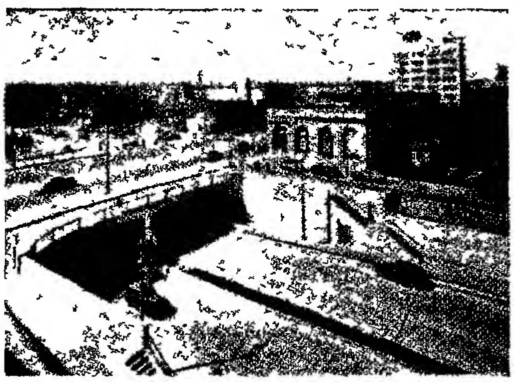
By JEAN ACKERMANN



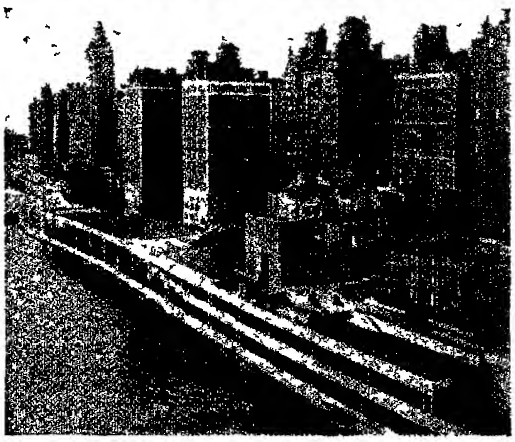
SUPERHIGHWAYS are in sight. Ten years after the war ends you'll be free to drive to 59 of 62 top-ranking U.S. cities on a ribbon-straight expressway, hitting an average of 65, and not stopping once unless you want to. Wherever you head, you'll be taking the quickest, though possibly not the shortest route, for you'll meet no stop lights, no hairpin curves, no crossroads, and no urban traffic.

Suppose you start out from Pittsburgh for St. Louis. You'll probably go around—not through—Indianapolis and Columbus, adding a mile or two but subtracting city congestion. When you near St. Louis, without disturbing through traffic you'll ease off the highway onto a city-service road that lands you right in the part of town you're bound for. You'll have saved wear on your tyres and temper, as well as considerable gas.

Something out of the World's Fair Futurama? Three years ago, yes—but now reckoned in terms of geography, employment, dollars, and cents, as well as traffic needs, it's ready for blue printing as soon as state highway departments okay their sections of it. This Pittsburgh—St. Louis route is just one branch of a country-wide Inter-regional System proposed by the President's committee of the same name in a report sent to Congress last January—a system which will neatly solve the problem of intercity connections and at the same time shrink urban traffic congestion to an all-time low.



DETROIT'S Davison Highway, which cuts a clean swath through the city by underpassing all intersections, keeps through city traffic hustling on its way and at the same time reduces the congestion of local traffic. City-service roads cutting off the main highway lead straight into town.



NEW YORK'S East River Drive was converted into a double decker at those points where it could not be laid in regular width. Actually this is far better design, for it provides separate north and south-bound traffic lanes.

The very fact that it's a plan should be good enough news for drivers weary of haphazardly built roads—one good, the next impossible. On top of this, it looks like good, sound thinking. Its excellence springs mainly from its recognition of two facts: (1) that most traffic (90 per cent) starts or ends in cities, and (2) that through and local traffic can't ride comfortably together. Running between and either through or around cities these expressways will drain off long distance traffic leaving byroads and urban streets free for local driving. Carefully planned and shrewdly routed for maximum service at low cost, the interregional roads, totalling only 33,920 miles, or one per cent of all our streets and roads, will bear 20 per cent of all the traffic in the country!

Since blueprints can be translated into construction in no time flat, work on these roads can start almost before the ink is dry on the Axis surrender—a telling factor in the relief of immediate postwar unemployment. Such swift action, coupled with the time lag generally expected before industry can retool for civilian-car production, might produce

(Continued on page 8)

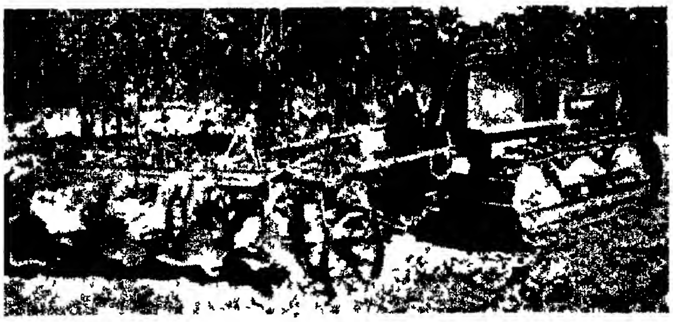
U. S. MARINES SOIL-CEMENT IN TRAINING (

US MARINE CORPS ENGINEERS at New Rivi
step construction procedure as part of the Eng
which is attached to the Engineer Battalion co
Nelson K Brown. One of the project completi
under the direction of Capt. Theodore Drummor
of a soil-cement roadway. Methods and machine
accompanying Marine Corps phot

EXISTING SOIL is shaped up by self-powered blade grader to receive cement

MARINE ENGINEERS distribute cement in paper containers along roadway

HAND RAKES and push brooms are used to spread cement uniformly over soil



SOIL AND CEMENT are mixed by gang-plow drawn by tractor

DISK HARROW pulled by tractor mixes soil and dry cement.

THOROUGH MIXING of soil and cement is provided by tractor-hauled Seaman Pulvi-Mixer

BUILD ROADS :OURSE

, N C, learn step-by-
ieer Equipment Course
imanded by Lieut-Col
l in this training course,
, was the construction
used are shown in the
graphs

UNIFORM FURROWS are made in material to prepare it for watering

WATER IS SPRAYED on dry soil-cement mix by tank truck

AFTER SPRAYING, wet materials are mixed with disk harrow hauled by International tractor

PULVI MIXER, following tank-truck, mixes soil and cement which has been saturated with water

MIXED MATERIAL (left) is shaped up by motor grader as road nears completion

ROLLER PULLS scratch drag (right) over roadway surface

SOIL-CEMENT ROAD is completed and ready for use

(Continued from page 5)

WHY ACCIDENTS HAPPEN

INTERSECTIONS

ROAD EDGE HAZARDS CAUSE DRIVERS TO HUG THE MIDDLE

UNDIVIDED TWO WAY TRAFFIC LEADS TO HEAD ON COLLISIONS

AS DO ROADS WITH UNDIFFERENTIATED SPEED LANES

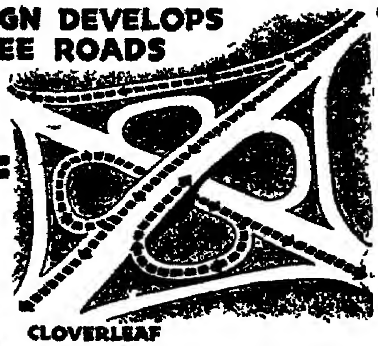
HOW ROAD DESIGN DEVELOPS ACCIDENT-FREE ROADS

ROTARY

A rotary is designed, in part, to enable cars to pass from one road to another without stopping At busy crossings, however, cars often get "boxed in" and find it hard to break away and leave the merry-go-round when they want to

UNDERPASS

The underpass, by completely eliminating the problem of the intersection, saves the motorists from becoming enmeshed with conflicting traffic. But it also limits the usefulness of the road by reducing the number of its entry points.



CLOVERLEAF

A combination of the rotary and underpass principles makes up the cloverleaf, which preserves the virtues of each while overcoming their deficiencies Although expensive to build, it compensates for its cost by eliminating traffic signals and patrols.

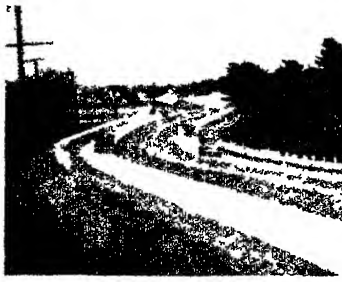
an interesting upset of our hoary slow-road swift car tradition Just as the fast Penn Turnpike of today leaves engines puffing so the new interregional roads, some with proposed minimums of 75 m p h might burn the bearings out of a '42 car (the only kind you'll be buying for the first year of peace), or even out of the new low-cost, low-speed cars that manufacturers have hinted at In any event, car manufacturers will have a chance literally to see the lay of the land, and to retool accordingly, for part of the system should be finished after a year

That's not quite so speedy as it sounds, for besides the fragments of these superways that already exist in finished form, the system will include old highways that need merely to be improved Key motorways like the Lakefront Freeway in Cleveland, the Oakland Express Highway in St Louis and the East River Drive in New York City, will serve as nuclei of the network, with existing connecting roads which will be improved if they fall below set standards Thus "building" these roads may mean large scale revamping of some, just widening or sprucing up others, and nothing at all to advanced expressways like those listed 'Preferential improvement," that is, construction priority over nonsystem roads, will hasten the completion date Construction, which will be state-supervised, will be paid for with funds contributed jointly by state and Federal governments

Can a limited plan, covering only one per cent of all our mileage effect sweeping changes throughout the country ? The answer is an emphatic "yes" Our roads today form a sprawling labyrinth that dates back to the horse and-buggy days Horses didn't shy at curves or hills, so our dirt roads took the lines of least resistance, letting natural barriers set their course Merchants, strong in the belief that traffic meant business, lobbied for routing these roads through the centre of town, while townspeople charged that the function of roads was to link towns as well as big cities The result is the present paradox of "through" roads that carry local traffic The popularity of driving causing a 1,000-per cent increase in highway mileage from 1925 to 1943, and raising the cry for "more roads everywhere"—though not necessarily good ones—often led to cheap, narrow roads that are highways in name only When Federal funds were voted for repair, either rural dirt roads got first attention, or major roads were merely repaved instead of being widened, graded, and modernized—thus preserving their infirmities in concrete

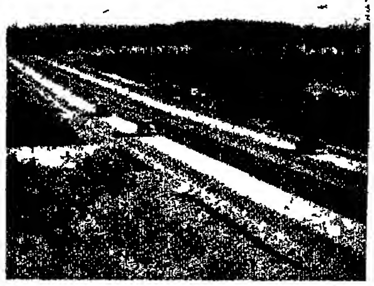
Highway technicians tried to warn the public of the coming headache—the headache that reached the nerve-racking stage just before Pearl Harbour

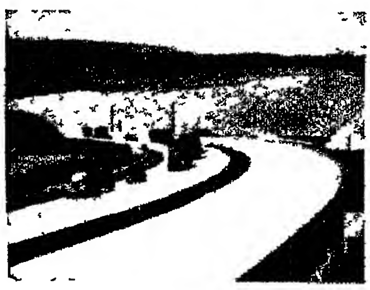
How Highways have been designed to avoid the worst Danger of the Road—A head-on collision



BAD The least effective way of preventing head-on smashups is to have white lines running down the centre of the road Sometimes the lines are flanked by rough asphalt in a feeble attempt to keep the motorist as far from the centre of the road as possible.

GOOD Dividing highways with raised sections, however, is an excellent way of keeping cars from swerving out of line and ramming into cars coming in the opposite direction Postwar designs have dividers four feet wide in urban areas and at least 15 feet wide in rural districts.





POOR Only slightly more successful is the dividing of the lanes with a strip of soft earth in which markers or small plants can be placed The road below is a section of the Pennsylvania Turnpike , the road at left is a part of the Providence-Hartford highway, Route 44.

FOOLPROOF The best way to prevent head-on smashups is, of course, the most obvious—by building separate one-way roads The interregional highway, proposed by a Presidential committee for construction after the war, will be built thus when possible.

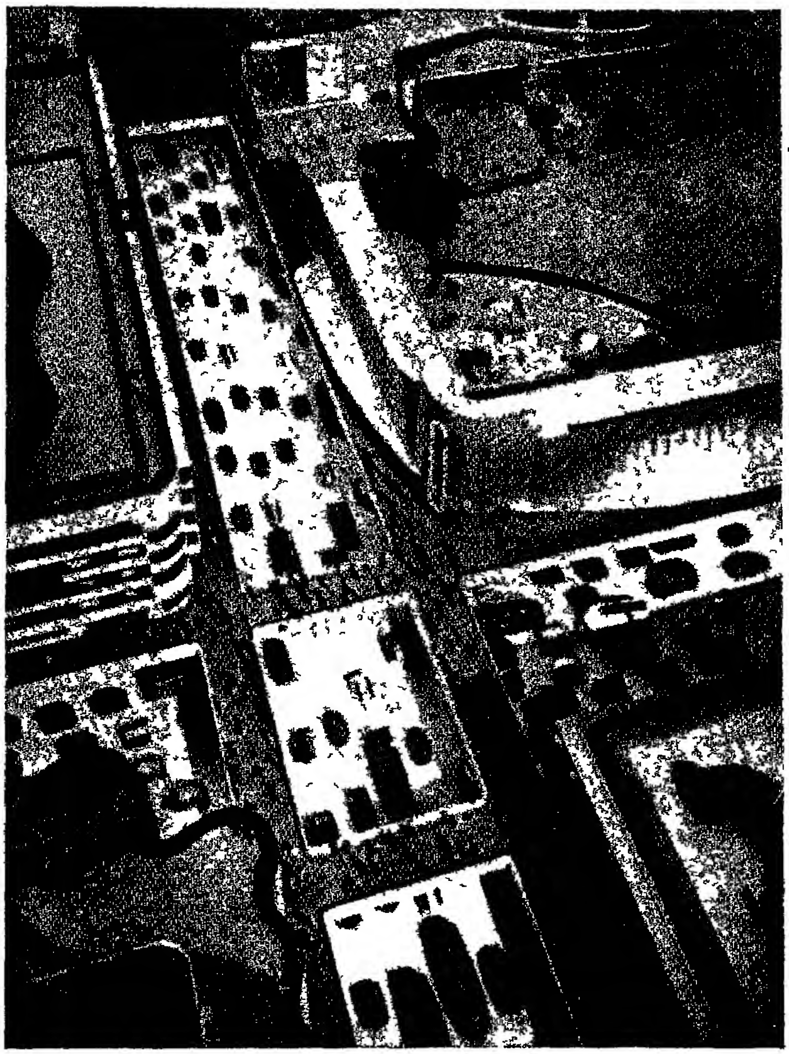
Merchants who had schemed for town-routed highways wailed loudly when they saw trade snowed under by traffic jams outside their stores Builders tried to cover up weak spots by installing intricate traffic systems, signs, and signals, but the job was too big for piecemeal patching The driver suffered coming and going

When it took an hour to creep through a fair-sized city, when Sunday trips home from the beach stretched out to Monday morning, it was finally recognized that something was very wrong Money-conscious legislatures began to relent Maybe a good wide, safe road *did* pay for itself Encouraged, planners began to unfold their dreams Some, like Norman Bel Geddes, designer of the Futurama, have suggested rebuilding cities, with separated pedestrian and motor-car levels Others, looking for a more immediate solution, are advocating coast-to-coast and Canada-to-Mexico highways that would skim off cross-continental driving, leaving local roads and streets for local traffic

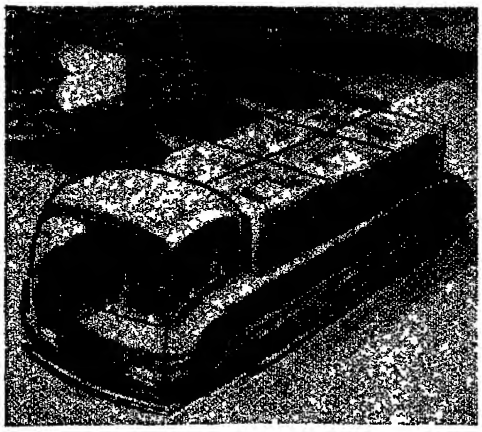
This last plan sounds inviting, but it overlooks the major cause and objective of most driving—cities In a report made in 1939, the Bureau of Public Roads junked this cross continental scheme and produced the germ of the present interregional plan The report also presented some rather startling facts Transcontinental traffic reaches barely 300 cars a day Eighty-five per cent of all car trips are under 30 miles Ninety per cent of all traffic found on main highways starts or ends in cities The nearer you get to a city, the more congested the traffic becomes These findings cried out for a network of intercity roads, with frequent access points near the cities for short-run traffic, service roads within city limits and by-passing or "through" roads for long-distance traffic This is precisely what the interregional roads will provide—and with amazing efficiency

These motorways will reach—and relieve—more than half of our cities with populations of 10,000 or more In addition, they will serve industrial centres and military and naval bases Their routes seem nearly perfect

Their design is perhaps more of a compromise between dreams and existing fact The roads will be expressways, on the model of Germany's *Autobahnen* and England's proposed motorways—free of crossings, with occasional access through smooth-running interchanges Interregional roads carrying over 5,000 cars a day will have no crossroads, while branches with less traffic may be allowed occasional crossings if provisions are made eventually to scrap them Access to the first two types of roads will probably be by cloverleaf interchanges, or some variation of this type of



TRAFFIC CENTRE In place of the crushing masses of people and cars that now jam the main thoroughfares of our cities, Norman Bel Geddes, in his World's Fair Futurama, promised the seemingly incredible tranquillity shown below by having all vehicular traffic on one level and the entrances to buildings on a higher level, which would be reserved solely for pedestrians



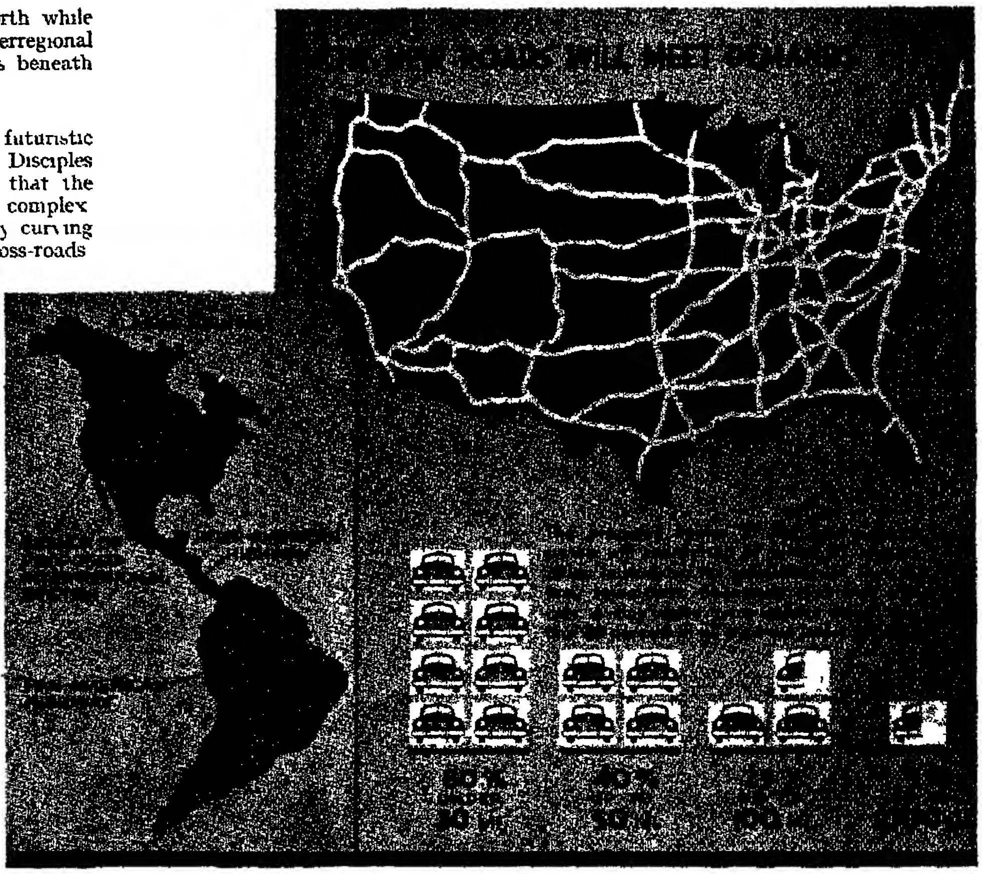
TRUCKS, light and streamlined, will transport their cargo in weight-saving plastic containers

Suggested by the mats used by the Air Forces in building emergency airfields (P S M Mar, '43, p 101), steel grating, with sand and oil filling in the interstices, is now being tested as a road surfacing Known to be nonskidding it has still to prove its ability to maintain a smooth surface

intersection. Where it isn't worth while to build an intersection and interregional road will be depressed to pass beneath a cross road.

So far this checks with futuristic ideals—except in one part. Disciples of Norman Bel Geddes argue that the cloverleaf is expensive and complex and suggest instead long gently curving ramps to ease traffic onto cross-roads. Although possibly superior this would involve highways of 16 lanes or more, which are out of the picture now.

The second shibboleth of a good motorway is the separation of traffic. Again compromising, separate oneway roads are specified wherever possible. Where they can't be laid median strips must be installed—four feet wide on urban highways, 15 feet wide on rural roads. In emergency cases, undivided two lane roads will be allowed to stand if they are designed so that ultimately they can be widened. Generally this is the provision for the "hardship cases." Four and six lanes are suggested for light and heavier traveled sections respectively.



The plan to span the Americas with one great highway will be brought nearer to reality with the construction of the U. S. interregional system. One day in the not too-distant future a motorist will be able to follow this road all the way from Fairbanks down to Buenos Aires.

Curves are to be kept to a high of nine degrees on slow stretches of road with stricter standards elsewhere, and all curves over one degree will be banked. Road edges will be gently sloped upward where possible, or faced with a retaining wall. Long sight distances are also specified. All calculations are based on minimum speeds of 75 m.p.h. in the country and 50 m.p.h. on roads leading through or past cities.

These are sensible outlines. By leaving the driver with a limited number of problems and decisions (the cloverleaf city-service roads, wide dividers all limit initiative and possible error) they approach the ideal of the road that drives the car.

But automatic street lighting that flashes on only when a car nears, automatic "dimmers" that lower headlight beams as a car approaches head-on, electronically controlled lane barriers to keed car from snaking in and out until it's safe to do so, adjustable traffic lights that switch red and green to suit the needs of passing traffic, 64-lane highways with slow, leisurely, fast express, and truck lanes—all these must wait some until our cities and towns themselves are rebuilt, others until the public is convinced that driving can be a robotlike job.

When Congress votes funds for state purchases of rights-of-way, interregional roads will be on their first legs. The tremendous job of rebuilding our highways will finally be done according to plan—and not by fits and starts, as it has been for so long. But besides this there'll be a lot of other road work to catch up on. Repair work, for instance. Small roads have done mighty jobs during these war years without a touch of face lifting. Estimates indicate that repairs are needed on as much as 150,000 miles of state roads alone. This was up to only last January and doesn't include city streets, which have taken a heavy pounding from wartime traffic.

Aside from this, increased air traffic will need land routes as well—flight strips, or paved runways, up to 5,000 feet long, joining or intersecting highways and intended as refueling or "whistle-stop" stations for passenger planes, and also access roads from airfields to industrial centres, to service the cargo traffic that most certainly will boom when transport planes begin to fly on daily schedules.—(*With acknowledgments to "Popular Science"*)

HIGH-STRENGTH CONCRETE

The development by the North Western University of a new type of concrete "stronger than steel and lighter than aluminium" is reported from the United States. According to the brief particulars so far to hand only one fifth of the customary amount of water is employed in mixing the concrete, the mixing being made possible by the use of a special vibrating process. For service as a substitute for structural steel columns, the new high strength concrete is compressed in steel wire spirals. Costs are stated to be one third of that of all-steel construction.—(*Chemical Trade Journal, London.*)

CONTRIBUTIONS.

Articles and photographs suitable for publication in "The Indian Concrete Journal" are always welcome and those that are accepted, will be paid for.

UNUSUAL DESIGN OF CONCRETE FLIGHT HANGAR

By **C. A MITCHELL,**
U S Engineer Department, Syracuse, N Y

DESIGNED primarily to provide rapid in and out movement of a number of planes simultaneously, a large flight hangar is nearing completion at the Buffalo, N Y airport The hangar was built according to the designs and under the supervision of the U S Engineer Department

The directive authorizing construction of the hangar called for seven units and two one-storey leantos, the latter being 30 ft wide and 200 ft long A clear interior height of 30 ft was required, though provision for movement of planes between bays was not Such movement was to be provided, however, if the cost was not excessive

Scarcity of both steel and lumber were strong influences in the selection of reinforced concrete as the medium of construction Scarcity of labour and the necessity for speed required the use of methods that would eliminate expensive form-work and hand labour The use of reinforced concrete, therefore, coupled with precast floor joists and roof planks, satisfactorily answered the designer's problems

Arched frame system of design first was considered, but was rejected because of the cost involved and the time which would be consumed in the erection of form-work Use of long transverse spans to permit movement of planes between hangar bays also was abandoned when it became apparent that such construction would be too expensive Accordingly, continuous rigid-frame construction was adopted

Main interior frames, running longitudinally, consist of seven spans having typical sections of 3×5 ft, deepened at the haunches to 10 ft 9 in at column faces Construction joints were provided just outside the haunches Typical interior columns are 4×3 ft in section, with the columns on the first interior bent increasing in depth to 6 ft at the soffit of the girder haunches End columns, designed to resist extremely heavy moments, are 10 ft wide

The frame supporting the hangar doors is made up of beams 11 ft deep and 3 ft wide These are supported on 3×5 ft interior columns and end columns 3×10½ ft The main frames are spaced 25 ft on centres They are tied at column lines by cross-beams 1 ft wide and 10 ft 7 in deep and at intermediate points with 16×16 in tiebeams

Use of precast roof joists spanning between frames and supporting the 3½-in concrete channel roof slabs greatly facilitated construction Roof slabs were securely anchored to the joists by bolted clips Two lines of 4 × 10½-in concrete bridging were cast in place in each joist span

To facilitate a convenient re-use of falsework, a system of wide flange beams carried by semi-portable timbers was adopted to support the forms Vertical adjustment of the girder alignment was accomplished by means of screw jacks

Unusual methods were adopted in concreting the main frames Beams were first placed in cross-like patterns with intersection of the arms centred on the columns Main frame beams were bulkheaded on both sides of the columns near the intersecting tiebeams, Cross-beams were bulk-headed at mid-points As general practice centre sections of the main frames were placed within 48 hours after the cantilever sections had been concreted

Supporting timber towers were erected on 10×10-ft mats of 4-in planks placed on mud-sills Towers were positioned at the mid-point of the main frames and under the end of the haunches on each side of the columns Falsework also was erected adjacent to the columns to support forms at those places

Main frame forms were supported by two pairs of 24-in, 100-lb I-beams resting on short 14-in I-beams and were spaced approximately 6 ft apart centre to centre I-beams also supported the cross-beam forms, the I-beams being supported by the false-work frames adjacent to the columns

Forms for the beams were constructed from 1×6 tongue-and-groove lumber with 4×4-in studs at 16-in centres At columns, three panels were first erected, then the steel was placed

Reinforced concrete of continuous rigid-frame construction, coupled with the use of precast floor joists and roof planks, was a satisfactory answer to the designer's problems.

Finally, the fourth panel was nailed on, closing the column form All steel for beams was placed and assembled in the forms No forms were lined, the exposed finished concrete bearing the rough lumber marking

As a general rule concreting of hangar bays was brought to stages of completion with the minimum of sacrifice toward finishing the job as a whole When unfavourable weather was imminent, the roof deck was placed and the building enclosed insofar as was possible so that the floor slab could be placed and other interior work done without too much interruption

Also as general practice, the floor slab was not placed until the roof above the deck was in place This permitted filled areas under the floor slab to settle, facilitated the curing of the concrete and reduced to a minimum use of the floor slab by the contractor's equipment

Floors were designed for a 37,000-lb wheel load The floor consists of an 8 in unreinforced concrete slab with expansion joints provided on the perimeter of hangar bays, and with alternate expansion and contraction joints of the dummy type dividing the floor area into 11-ft strips

Inasmuch as most of the hangar floor was placed on fill, it was deemed advisable to provide a compacted gravel base for the floor slab It was also believed that the gravel would permit better under drainage and would reduce the probability of uneven settlement from superimposed loads

Another feature of the entire improvement at this airport is the plane parking apron which was built of rolled concrete This construction was adopted for its anticipated savings To conform to existing topography, the apron was built with an approximate 1½ per cent slope away from the building The rolled concrete was built uniformly 7 in thick Marginal drainage relieved the sub-base of excess moisture

Timber towers supporting form-work were erected on 10 × 10 ft mats placed on mud-sills Towers were positioned at the mid-point of the main frames and under the end of the haunches on each side of the columns

This type of work was in the experimental stage so far as both the engineers of the Syracuse District and the contractor were concerned In general, the recommendations of the Portland Cement Association for rolled concrte were followed The apron was laid on a 4-in bed of bank-run gravel Concrete was placed in 75 × 120-ft staggered blocks, with expansion joints enclosing each set of two blocks Forms edges of adjoining slabs, and string lines across centre block areas controlled finished grade

After some experiment the concrete mix found to be the most satisfactory consisted of 30 per cent gravel, 60 per cent sand and 4 sacks of cement per cu yd Density obtained was approximately 136 lb per cubic foot

Concrete for the apron was hauled to the site in 5-yd transit mixers from a plant 4½ miles away It was deposited in windrows then spread with a patrol grader Compaction was obtained with a three-wheel, 10-ton roller and with another roller equipped with large air plane tires These tires at first stuffed the surface, but after projecting treads had been buffed, satisfactory surface finish was obtained At first an attempt was made to obtain a brush finish by fogging the rolled concrete with moisture, and then brooming with a heavy broom This practice was discarded when it was believed that the surface was being weakened

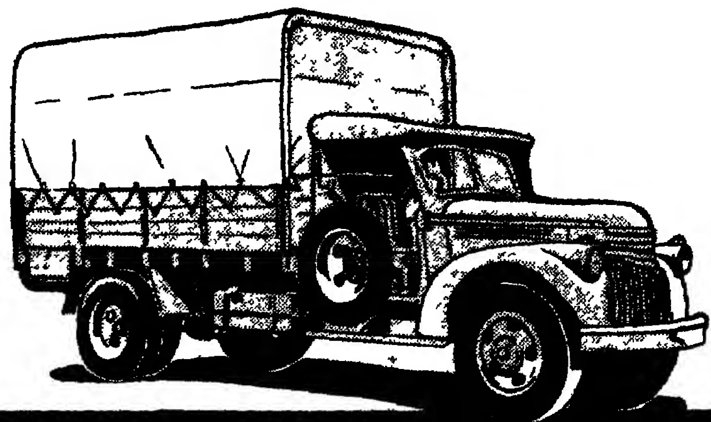
Experience on this job indicated that best results would be obtained by limiting placement and rolling of lean-mix concrete to lanes not over 25 ft wide Thus surface defects can be corrected as work progresses without the need of planning the entire 75 ft as was the case on the Buffalo job

Despite such construction disadvantages, the obvious value of rolled concrete is the saving represented by a reduction in finishing labour and machinery

In order to facilitate a convenient re-use of form-work, a system of wide flange beams carried by semi-portable timbers, was adopted to support the forms Girder alignment was adjusted vertically by screw-jacks

The flight hangar is a noteworthy example of functional design Exposed structural elements denote strength and durability and their arrangement is æsthetically pleasing The massive columns on the east and west sides of the structure are boldly revealed, giving the effect of buttresses What otherwise might be a monotony of horizontal lines is softened by strong vertical ones

Designers began work on the flight hangar May 10, 1943 Final plans and specifications were completed on schedule The structure was erected under the jurisdiction of the Syracuse District, U S Engineer Department, and under the direct supervison of the Western Area of that district Designers were Duane Lyman and Associates, Buffalo, assisted by Thomas H McKaig, structural engineer The general contractor was Poirier and McLane of New York City —(*With acknowledgments to "Concrete"*)



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KURALI
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LALAMUSA
LALIAN
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LOHIAN KHAS
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MALSIAN SHAHKOT
MANDI BAHAUDDIN
MANSA
MARH BALOCHAN
MANDI BUREWALA
MANDI STATE
MANGWAL
MARDAN
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R. S. Sarai Alamgir
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MURIDKE
MINCHINABAD
MIRAN SAHIB
NAKODAR
NANKANA SAHIB
NARANG
NAROWAL
NAWANSHAHR DOABA
NOWSHERA
NURKOT
NURMAHAL
NURPORE ROAD
NAGROTA
OKARA
PALAMPUR
PARACHINAR (*Via Thal*)
PASRUR
PATHANKOT
PAKPATTAN
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MIANCHANNU
MINCHINABAD
PINDIGHEB
PATTOKI
PESHAWAR
PHAGWARA
PHILLAUR
PHULERWAN
PIRMAHAL
PIND DADAN KHA
PIPLAN
QADIAN
QILLA SHEIKHU PURA
QILLA SOBHA SINGH
RAHON
RANBIRSINGHPURA
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SANAHWAL
SANGLA HILL
SILLANWALI
SARAI ALAMGIR
SARGODHA
SARNA
SATNAUR BADESRON
SHAH ALAM
SHAHDARA
SHAKARPUR (*R S Shahdara*)
SHAHPUR SADAR
SHAH CHAURASI
SHORKOT ROAD
SHUJABAD
SIALKOT
SIHALA
SIMLA
SIRHIND
SOLON
SUKHO
SULTANPUR LODHI
SUKHEKE
SRINAGAR
R. S. Havelian or Rawalpindi
TALAGANG (*R S Chakwal*)
TALWANDI
TARN TARAN
TANDA URMAR
TANDIANWALA
TANK
TAXILA
THERI SANSI
TEHSIL SHAKARGARH
THABALKE
THAL
TOBA TEK SINGH
VEHARI
VERKA
WAZIRABAD
WARBURTON
WASAWEWALA

NEW DELHI AREA :—

AGRA
ALAL
ALIGARH
AMROHA
AMBALA CITY
AMBALA CANTT
ATRAULI ROAD
BABRALA
BARHAN
BABARA
BARNALA
BAGHPAT ROAD
BAH (R S Belanganj)
BAHADURGARH
BAHJOI
BARETA
BASIKIRATHPUR
BAGAMABAD
BHIWANI
BHUCHCHU
BALLABGARH
BARAUT
BUDHLADA
BULANDSHAHR
BIJNOR
BRINDABAN
CHANDAUSI
CHANDPUR SIAU
CHOLA
DADRI
DALMIA DADRI
DIBAI
DEHRA DUN
DELHI
DELHI SHAHDRA
DEOBAND
DANKAUR
DAURALA
DHAMPUR
DHANARI
DOIWALA
ETMADPUR
FARIDABAD
FEROZABAD
GANAUR
GANGOH
GARHMUKHTESAR
GHAZIABAD
GHARAUNDA
GOT
GOHANA
GURGAON
GULAOTHI
HALDAUR
HANSI
HARDWAR
HAPUR
HATHRAS
HISSAR
HASANPUR (R S Gajraula)
JAGADHRI
JAKHAL
JALESAR ROAD
JAWALAPUR
JIND CITY
JULANA
KALANWALI
KANTH
KANDHLA
KAURARA
KHATAULI
KHEKRA
KHURJA
KARNAL
KAITHAL
KASHIPUR
KASIMPUR KHERI
KOSI KALAN
KOTDWARA
KURUKSHETRA
LEHRAGAGA
LHAKSAR
LOHARU
MANDI DHANAURA
MADLAUDA
MANSURPUR
MEERUT
MILAK
MORADABAD
MUNDLANA
MURADNAGAR
MURSAN
MUTTRA
MUZAFFARNAGAR
NAJIBABAD
NAGARIA SADAT
NAGINA
NABHA
NANAUTA
NARELA
NARWANA
PALWAL
PANIPAT
PATIALA
PILKHUWA
RAIWALA
RAJA KA SAHASPUR
RAJGHAT-NARORA
RAJPURA
RAMAN
RAMNAGAR
RAMPUR
RAMPUR MANHIARAN
RAMPURA PHUL
RAYA
REWARI
ROHTAK
ROORKEE
RIKHIKESH
SAFIDON
SAHARANPUR
SAMPLA
SANGRUR
SASNI
SUNAM
SAMALKHA
SAMBHAL HATIM SARAI
SARSAWA
SEOHARA
SHIKOHABAD
SHAHABAD MARKANDA
SHAMLI
SIRSA
SONEPAT
SIMBHAOLI
TAPA
TAPRI
THANA BHAWAN
THANESAR
TUNDLA
TOHANA
UCHANA
UKLANA

CAWNPORE AREA —

ACHALGANJ
ACHHALDA
AGSAULI
AHIMANPUR
AHRAURA ROAD
AJGAIN
AJODHYA
AKBARPUR
ALIGANJ
ALLAHABAD
AMETHI
AMOUSI
ANJHI
ANUPGANJ
AONLA
ASAFPUR
ATARRA
AURAIYA
AUNRIHAR
AZAMGARH
BABHNAN
BACHRAWAN
BADSHAHPUR
BAHERI
BAHRAICH
BAHRAMGHAT
BAISWARA
BAITALPUR
BAKSHA
BALAMAU
BALLIA
BALRAMPUR
BAMIANA
BANBASSA
BANDA
BANGAR MAU
BARA BANKI
BAREILLY
BARHAJ BAZAR
BARHNI
BARAHALGANJ
BASAI
BASHARATGANJ
BASTI
BELLARIEN
BELTHARA ROAD
BENARES CANTT
BENARES CITY
BEWAR
BHADOHI
BHARTHANA
BHATPARRANI
BHATNI
BHITAURA
BHITI
BHONGAON
BIJAURIA
BILGRAM
BILPUR
BINDKI ROAD
BISALPUR
BISWAN
BODARWAR
BRIDGMANGANJ
BUDAUN
BURHWAL
CAMPIERGANJ
CAPTAINGANJ
CAWNPORE
CHANDAULI MANJHWAR
CHANDWAK
CHAURICHAURA
CHHITAUNI
CHHIBRAMAU
CHILBILA
CHILH
CHILWARIA
CHIRGAON
CHIT BARAGAON
CHOWKAGHAT
CHUNAR
COLONELGANJ
DARYABAD
DARYAOGANJ
DATIA
DHEENA
DIBIAPUR
DILDAR NAGAR
DOBHI
DOHRIGHAT
DULAHPUR
ETAH
ETAWAH
FARRUKHABAD
FATEHGARH
FATEHPUR
FYZABAD
GAHMAR
GANJDUNDWARA
GAURIGANJ
GHAZIPUR
GHOSI
GHUGHLI
GOLA GOKARANNATH
GONDA
GORAKHPUR
GOSHAINGANJ
GURSAHAIGANJ
HAIDARGARH
HALDWANI
HANDIA KHAS
HARDOI
HARGAON
HARNAMGANJ
HARPALGANJ
HARPALPUR

Cawnpore Area *(Contd.)*

JAHANAGANJ ROAD
JAIS
JAKHANIA
JALALPUR
JANGHAI JN
JANGIGANJ
JARWAL ROAD
JASWANTNAGAR
JAUNPUR
JEONATHPUR
JHANSI
JHUSI
KABRAI
KACHHLA GHAT
KACHHWA ROAD
KADIPUR
KAIMGANJ
KALPI
KAMALGANJ
KAMALPUR
KANAUJ
KANCHAUSI
KARARI
KARENGI
KARWI
KASGANJ
KASHI
KATHGODAM
KATHKUIYAN
KATKA
KAWAPUR
KEORIPUR
KERAKAT
KHADA
KHAGA
KHALILABAD
KHATEMA
KHETA SARAI
KHORASAN ROAD
KICHHA
KIDIHDAPUR
KOHNDAUR
KONRH ROAD
KOPAGANJ
KUNCH
KUNRAGHAT
KUSMHI
LACHHMIPUR
LAKHIMPUR KHERI
LAKSHMIGANJ
LALGANJ
LALITPUR
LAR ROAD
LUCKNOW
MADHOGANJ
MADHOSINGH
MAHMUDABAD
MAHOBA
MAHOLI
MAHPUR
MAINPURI
MAKHANDPUR
MALIHABAD
MALIPUR
MALLAWAN
MANAURI
MANDAH ROAD
MANKAPUR
MANPUR NAGARIA
MAREHRA
MARIAHU
MASKANWA
MAU AIMA
MAU NATH
BHANJAN
MAURANIPUR
MEJA ROAD
MIRANPUR KATRA
MIRZAPUR
MISRIKH TIRATH
MOGHAL SARAI
MOTH
MUHAMMADABAD
GOHNA
MUNDERWA
MUSAFIRKHANA
NAGARIA SADAT
NAIPALGUNJ ROAD
NANDGUNJ
NANPARA
NAUTANWA
NAWABGUNG
GONDA
NIBKARORI
NOWGARH
ORAI
ORCHHA
PACHPERWA
PADRAUNA
PARIAWAN
PARTABGARH
PATIALI ON
GANGES
PAYAGPUR
PEPPEGANJ
PHAPHUND
PHARENDA
PHARIHA
PHEPHNA
PHULPUR
PIPRAICH
PITAMBERPUR
PILIBHIT
PUKHRAYAN
PUNCH
PURANPUR
RAGAUL
RAGHURAJ SINGH
RAI BARELI
RAJA-KA-RAMPUR
RAJA TALAB
RAJAWARI
RAMKOLA
RANI-KI-SARAI
RASAULI
RASRA
RASULABAD
REOTI
RICHHA ROAD
RISIA
RUDAIN
RUDAULI
RURA
SAADAT
SAFDAR GANJ
SAFIPUR
SAHATWAR
SAHAWAR TOWN
SAHJANWA
SAIDPUR BHITR
SAIYEDRAJA
SAKALDIHA
SALIMPUR
SANDILA
SARAIMIR
SARDARNAGAR
SARJU
SHAHGANJ
SHAHGARH
SHAHJAHANPUR
SHAMSHABAD
SHEIKHUPUR
SHIVPUR
SHOHRATGARH
SHRI KRISHNA
NAGAR
SIDHAULI
SIKANDARPUR
SIKANDRA RAO
SIROTARGHAT
SISWA BAZAR
SITAPUR
SORON
SULTANPUR
SURAIMANPUR
SURJAWAN
TAHSIL DEORIA
TAHSIL FATEHPUR
TAKIA
TAMKOHI ROAD
TANAKPUR
TANDA
TARAON
TARIGHAT
TILHAR
TIKRI
TULSIPUR
UJHANI
UNAO
UNCHAULIA
USKA BAZAR
WALTERGANJ
YADVENDRA NAGAR
YUSUFPUR
ZAMANIA

COLOURED CONCRETE FOR ADVERTISING DISPLAY

ON the whole, the Industrial District of Sewree, Bombay, looks pretty drab But Mr H K Hirth, Managing Director of The Firestone Tyre & Rubber Co, of India, Ltd, whose plant is there located, believes in a touch of brightness The lawns and privet hedges which flank the Firestone offices are delightful to the eye, and a challenge to all who say that Industry must proceed in colourless surroundings

One spot remained to scar the attractive surroundings of the plant, the gable end of the factory expansion building which is aligned with the rear of the office block Here, on a bare wall, has been projected a pleasing sign in cement and Colorex plaster The base colour of the sign harmonises with the colour of the office block A facsimile of a Firestone tyre 20 feet high is surmounted by the legend "Firestone" in red 4-foot letters Underneath, on either side of the tyre display, runs the slogan "At the service of the nation" in blue Colorex plaster

Bharat Tiles & Marble Limited carried out the work to the instructions of Stronach's Publicity Services, Ltd The work is a testimonial to the fact that the famous skill of Indian Artisans is still preserved

A MODERN HOUSE IN SANTIAGO

Photo Fenno Jacobs, Three Lions New York

CEMENT CONCRETE IS THE BASIS OF NEARLY ALL POSTWAR CONSTRUCTION.

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The INDIAN CONCRETE JOURNAL

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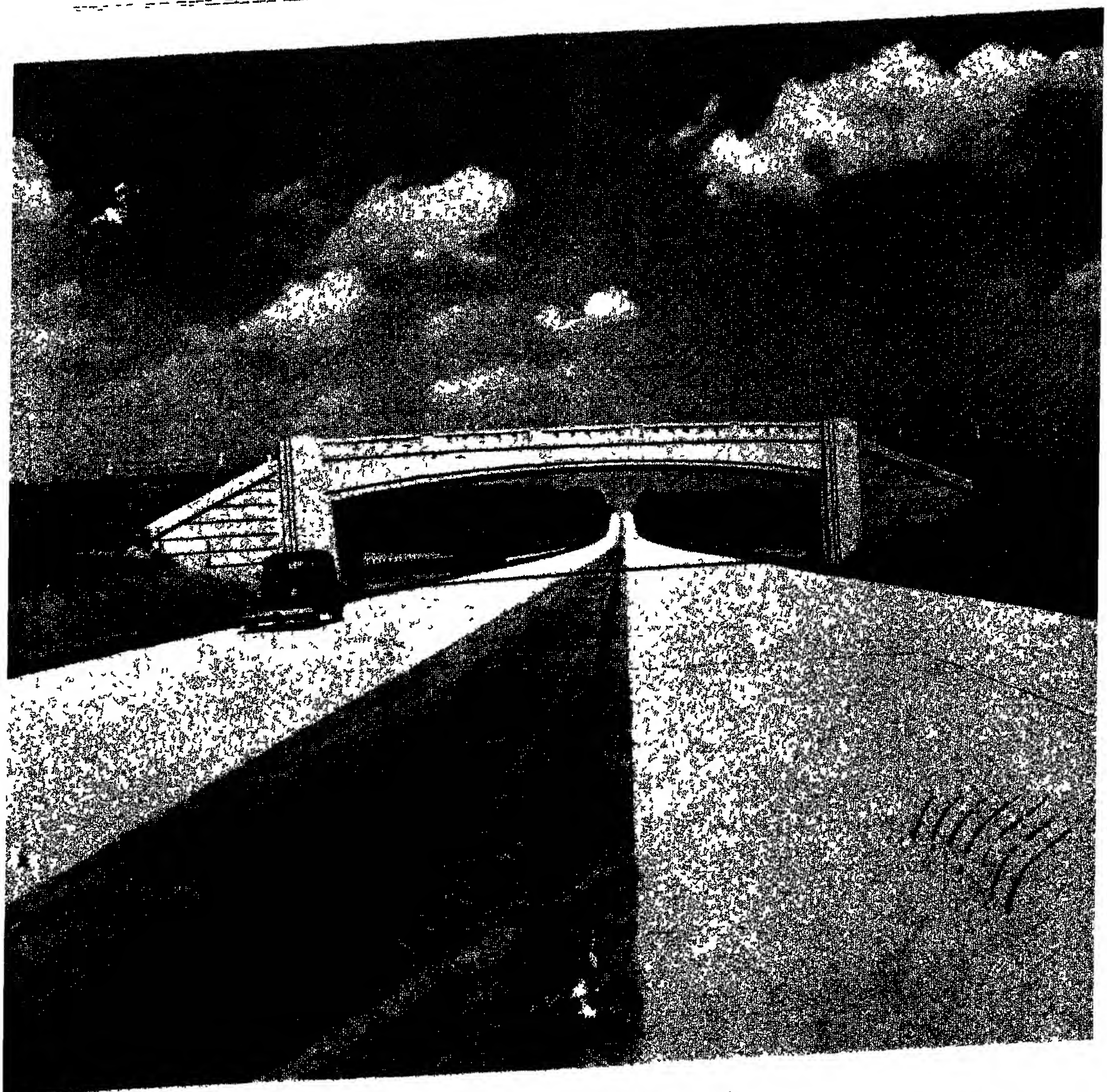
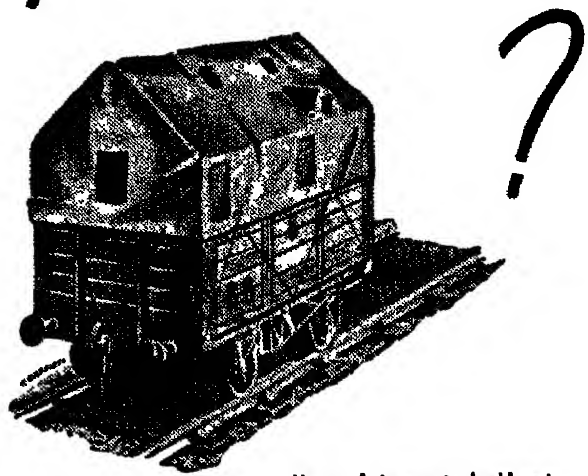
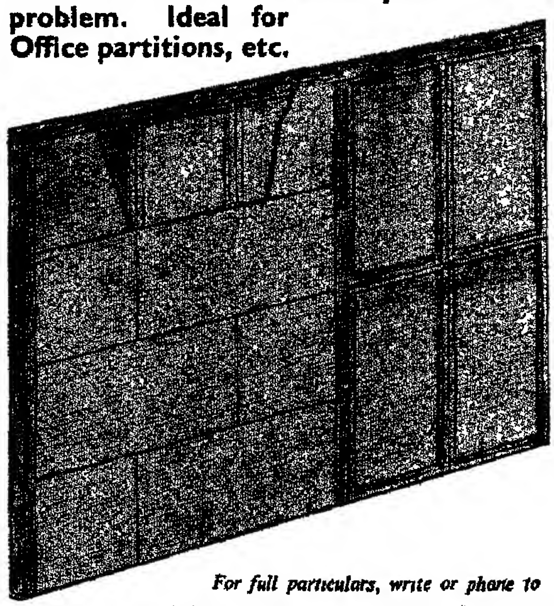


A NEW SUPER-HIGHWAY, U S A

(See Back Cover)






UP-TO-DATE PLANT FOR
EFFICIENCY & ECONOMY
MOBILE STONE BREAKING, SCREENING & TAR MACADAM PLANT
For Road Contractors and Municipal Authorities
Now is the time for quarry concerns to secure a lead by buying superior equipment for producing aggregates for road making, concrete constructions, tarred and bituminous stone and chippings
Road and constructional engineers will demand aggregates of high quality, structural strength, uniform cubical shapes well graded, and at a moderate price How then can this be assured?
Marsdens' have over a century's practical experience in designing, manufacturing and installing stone-breaking and screening plant. Their successful adaptation of roller bearings to this type of machinery provides the answer Marsden machines give quicker and better production, at a lower cost.
Primary breaker double toggle Sizes from 12×9 to 48×36.
Secondary breakers single toggle Sizes from 12×8 to 42×15
Granulators, Sizes from 12×6 to 42×6
Patent Ro o-snap Impact Granulator
Double Paddle Tar or Bituminous Macadam Mixer
Oil fired Rotary Dryer
Long type Rota-Vibra Screens.
We are also able to supply Breakers and Granulators in all sizes with plain bearings
Mobile Stonebreaker
Mobile Granulator
Mobile Rotosnap Impact Granulator
Mobile Tar Macadam Plant
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February 15th, 1945

The INDIAN CONCRETE JOURNAL

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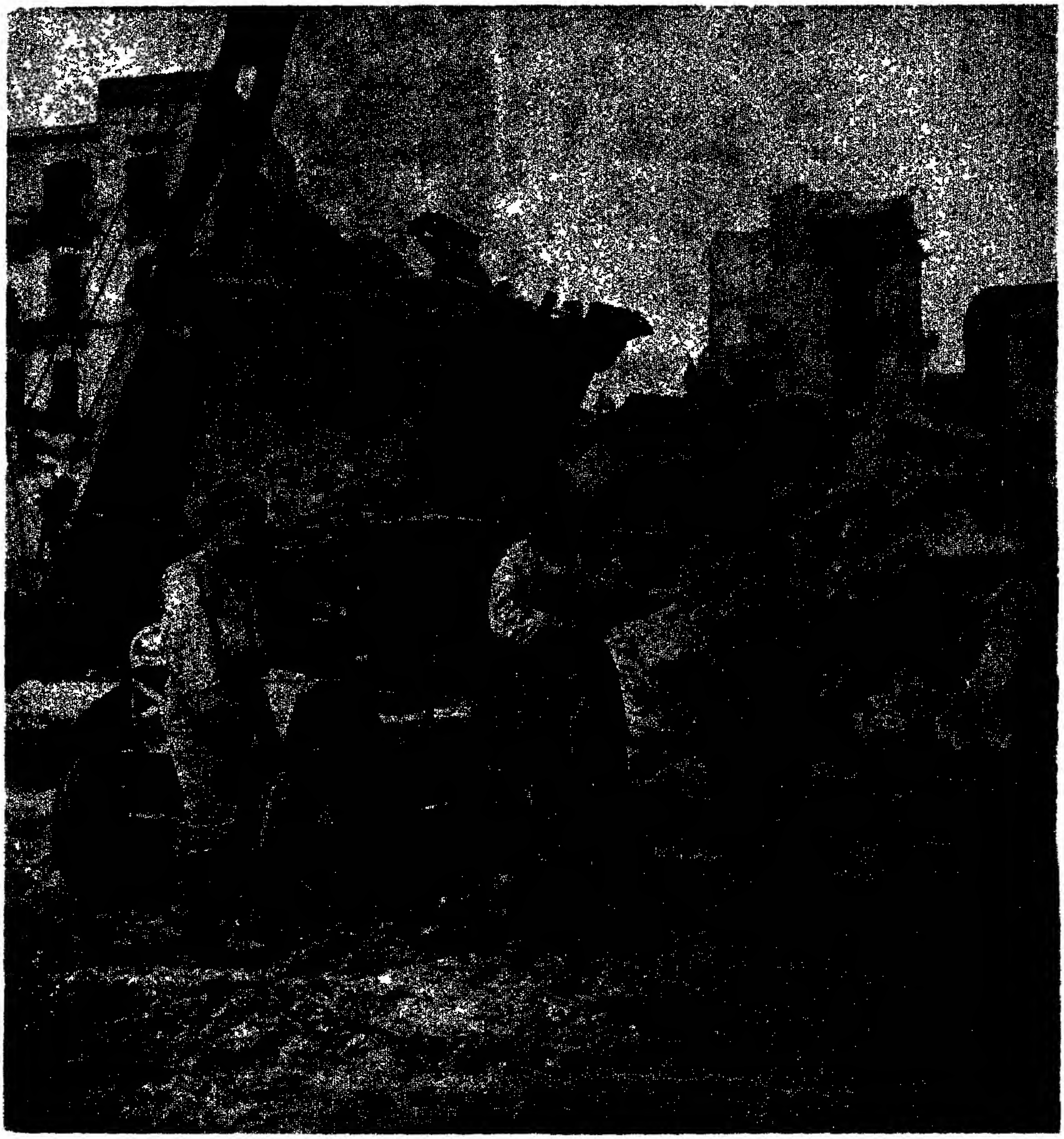


American and British engineers and construction equipment work together in removing battle debris from Naples, foreshadowing a post-invasion task that will be duplicated in many other European cities during 1945.

EDITORIAL NEWS & NOTES

The Institution of Engineers (India)

THE 25th Annual General Meeting of the Institution of Engineers (India) was held at Hyderabad, Deccan, from the 2nd to the 5th of January. In taking over the Presidentship Mr H P Bhaumik delivered a most impressive address in which he dealt with the representation of the Institution in reconstruction committees, post-war technical education, engineering research, development of electric power, both by Hydro-electric and thermal schemes, and finally development of tele-communications on which subject Mr Bhaumik is an accepted authority

Mr C E Preston's paper on "post-war education and training of engineering personnel" had a very good reception, and a sub-committee was appointed to deal with this and other developments in technical education Other papers dealt with were Mr A N Mitra's "Training of Rivers," Mr V R Vaidya's "Planning for post-war electric power," and Mr Subrahmanian's "The Design of small Sewage Disposal Plants" A very pleasant visit to Nizamsagar and Pocharam Irrigation Projects completed the meeting

All the arrangements did credit to the Hyderabad Centre who are ably keeping up the reputation of the State regarding hospitality

* * *

A very successful annual meeting of the Bombay Centre of the Institution of Engineers (India) was held in Bombay on the 18th of January, under the Chairmanship of Rao Bahadur N S Joshi, who gave a very interesting speech on "Food and Irrigation Problems affecting India in general and Bombay in particular" The whole question of the food supply for the great population of this country is of vital importance India's irrigation works are at present distributed very unevenly and Bombay Presidency has much leeway to make up The irrigated area of about one million acres forms about 4% only of the annual sown area The Rao Bahadur explained in some detail that irrigation works in the Bombay Deccan were extremely costly While it requires only Re 1/- of capital on the construction of canals for Re 1/- of annual produce in the Punjab, Bombay requires Rs 8/- of capital on the construction of canals and tanks for one rupee worth of annual produce The other main source of water must be by wells These in the past have been constructed by owners of lands and not by Governments Rao Bahadur Joshi appeals to the Government to construct many wells in future Owing to the peculiar geological formation of the Deccan Trap Rock, the question of constructing wells is very difficult, and poor cultivators cannot risk the venture As this matter seems to us of the greatest importance, we propose to give a summary of the Rao Bahadur's paper in the March issue of this Journal

A somewhat heated discussion took place on Sir Claud Inglis' paper on "Proposed Extension to the Water Supply of Bombay" The upshot of it all was that the decision between the two proposed schemes should be made at once and work started immediately as the water supply for Bombay with its present swelling population would be precarious indeed if nature was unkind in producing a bad monsoon Other papers dealt with were "Longevity of Wells in the Deccan Trap area" by Mr D G Limaye and "Automatic Flood Recorders for Storage Reservoirs with Overflow Weirs" by Mr G P Nagarkar, while on the last day Mr H J Mulleneux gave a wonderful display of his electrical Oscillations or electric rays Mr S B and R N Joshi's paper on "One-sided contracts for Construction Work" caused so much discussion that this had to be postponed to a later date

After a successful lunch party at the Taj Mahal Hotel the party visited the Hind Cycle Factory at Worli, thereby encouraging the manufacture of one of India's future means of communications If only we can get roads for the cycles to go on, this humble machine should do its full share in developing the country

* * *

VILLAGE IMPROVEMENT WITH CEMENT

A practical demonstration at Virar (38 miles from Bombay)

The important role that cement is bound to play in post-war rural planning was demonstrated practically at Virar by the Concrete Association of India on the 28th of January Mr. G F S Collins, C S I, C I E, O B E, I C S, Adviser to H E the Governor of Bombay, inaugurated the various improvements carried out, and a full text of his address is published herewith The function was attended by a small but distinguished gathering which included Sir Charles Bristow, Kt, C I E, I C S, Adviser to H E the Governor of Bombay, Mr G V Bedekar, Collector of Thana, Mr H G Vartak, Chairman of the Virar Village Panchayat, well-known Municipal and P. W D officials, and other District Local Board members.

Mr Kynnersley, in a short speech asking Mr Collins to inaugurate the improvements, said that although planning was the duty of Government, in these days of scarcity of practically everything, it seemed right to help the Government and the people to understand something of the village structures in which cement played a prominent part The work they had done was meant to be of permanent use to villagers in Virar, as well as to serve as an example to other villages

The visitors were then shown around the various items of improvement work which comprised the following —

1. A new village house incorporating concrete features as roofing, plastering, flooring, jalli work, ventilators, sun-shades, etc
2. A permanent grain silo attached to the house.
3. Improvements to the District Local Board well, the approach-way and construction of a new drinking fountain
4. Creteways—a short length of 400 ft
5. Single track of concrete—for use in all weather by bicycles, and single-wheeled hand carts and bullock carts
6. Clean and hygienic platforms to village market
7. Concrete flooring in Dharamshala (travellers' rest house)
8. Surface Drains
9. 'Athanis' (road-side platforms for headloads), lamp standards, cycle parking blocks, etc

The entire improvement scheme was financed by The Cement Marketing Co of India, Ltd

We hope to publish in the next issue photographs depicting the above improvements

* * *

Address delivered by Mr G F S Collins, C S I, C I E, O B E, I C S, Adviser to H E the Governor of Bombay on the occasion of the inauguration of village improvements at Virar

"LET me begin by thanking on behalf of all of us Mr Kynnersley and The Cement Marketing Company for inviting us to this function to-day, for making such efficient arrangements and for their kindness and hospitality I should also like to emphasise very strongly the instructional value which all of us—I am sure we are all equally interested in the future rural development of India—will derive from seeing this experiment

I regard this experiment as of particular importance when the minds of Government and the public are turned towards a better and more prosperous India after the war, and when, with what we now know will be an early and happy conclusion of the war, Government is engaged in planning post-war development Some of you must be aware of the so-called Bombay Plan drawn up by ten leading industrialists and public men which gives the ideal of a post-war India. I should not be exaggerating if I say that Mr Kynnersley and his Association have long ago envisaged this picture They have for many years been drawing our attention to the importance of roads, they have more recently prepared pilot schemes for roads in four talukas of this Province and now they have given us this concrete example—I use the word concrete in two senses—of what post-war planning should be I regard Mr Kynnersley and his Association as

forerunners of progress who have seen ahead of Government and the public and Mr Kynnersley, working as he has worked for many years assiduously and yet unostentatiously, may well be ranked among those ten pioneers to whom I have referred

You have probably all seen the pamphlet of the Bombay Government entitled " Bombay's Countryside " which gives an account of its post-war development plans, and you will know that those plans begin from and attach primary importance to the villages To give a few instances, roads opening up all villages with a population of 500 or more will take precedence over other roads and for the first five-year period certain concentrated areas, mainly areas which have given many soldiers to the war, have been selected for intensive development The plan contemplates that central villages in those areas which we may name Centres of Civilization will have schools dispensaries, chavdies, village clubs, houses for returned soldiers and so forth in accordance with modern ideas of civilisation and that rural life will radiate outwards from these villages Government has gone still further since that plan was published and now hopes and intends to put the plan, so far as materials and labour are now available, into action in one taluka in each of the three divisions of the Province before the war concludes Those talukas will be Satara in Satara District, Khed in Ratnagiri District and Bulsar in Surat District and three officers have been appointed to work out detailed plans This countryside ideal contemplates model type plans for the buildings I have described These buildings must be fully suitable to fulfil the needs for which they are constructed; they must be modern and must present an attractive appearance and yet must not cost more than the tax-payer can afford It is therefore evident that Government must make use of the best brains and the best experience it can command to evolve those type plans

I say this by way of illustrating the ideal before us and of emphasising the importance of this experiment at Virar which we have seen to-day and of expressing our gratitude to Mr Kynnersley and his Association for their far-seeing and public-spirited effort. It was clear enough that cement must be the main material for village buildings of the future, but I am afraid that even Mr. Kynnersley, conjurer as he may be, will not be able to produce hidden supplies of that material for our initial work in the three talukas, nor do I expect that he will be able at this stage to guarantee its future price at a figure to suit the tax-payer's pocket That will, however, not prevent us from being cement-minded

Let me conclude by thanking the Panchayat of Virar and its Chairman, Mr Vartak, for their co-operation in this effort. Although the resuscitation of panchayat life, which was one of the main objects of the late Government, has not progressed as we hoped, I am glad to see that Virar is an exception and I hope that this achievement and to-day's function will be an incentive to others to follow its example "

TYRES FOR MOTOR TRANSPORT VEHICLES

HOW TO OBTAIN RELIABLE SERVICES AND HIGH MILEAGE

IN view of the acute shortage of motor tyres and the need, therefore, to keep every tyre in service for the maximum mileage possible, the Government of India in the Department of War Transport have issued a very interesting pamphlet explaining the causes of unsatisfactory service and the precautions to be taken to get higher mileages

The following is a summary of the hints for conservation of tyres

(1) *Take special care to have tyres inflated and maintained at the correct pressure as declared by the makers Pressure should be checked at least twice weekly, better daily Always replace the valve-caps and screw down properly* The recommended inflation pressure for a tyre of the size of 30" × 5" is 75 lbs per sq inch and the load the tyre can carry at that pressure is 2,000 lbs , for a 32" × 6" tyre a pressure of 80 lbs and a load of 2,650 lbs , and for a 34" × 7" tyre a pressure of 85 lbs and a load of 3,300 lbs The maximum load that can be put on a tyre decreases with a fall in the tyre pressure In the 32" × 6" tyre, for example, if the tyre pressure is allowed to fall by only 5 lbs per sq inch, the permissible total load is reduced by about 6 per cent., and if the pressure drop is 10 lbs the reduction for safe loading amounts to nearly 13 per cent The corresponding percentage loss in payload is far higher Under-inflation causes rapid uneven tread wear, while over-inflation not only increases the danger of ' bruising " but also causes abnormal wear due to decrease in road contact

(2) *Avoid over-loading and uneven load distribution* Even when the total load is within permissible limits, it is important to avoid maldistribution of the load over the front and rear axles or the off and near wheels of either axle. Otherwise blowouts and separation may result. The axle " sags " when a heavy and unevenly distributed payload causes the body to lean more on one end of the axle than the other In the case of dual wheel assembly, a sagging axle forces the inside tyre to carry more than its share of the load, causing fast and irregular wear on the inside shoulder of that tyre

(3) *Do not travel at excessive speeds nor take corners otherwise than slowly Get off the mark slowly and do not use brakes suddenly, except in emergency* At high speeds the rubber of the tread softens due to accumulation of heat and wears off very quickly Driving at 20 miles per hour will give an increase of 7 per cent in the life of the tyre compared with an average speed of 25 miles An increase from 25 to 30 miles per hour will give a loss of life of 9 per cent, and an increase from 30 to 35 miles per hour a further loss of 11 per cent These are important figures when tyres are scarce

(4) *Give the tyres frequent inspection and remove all stones, spines and small nails from the tread Have all repairs attended to at once " Hot patches " are useful as temporary expedients They are not suitable for heavy transport Vulcanisation is essential Always apply french chalk when fitting inner tubes.*

(5) *Practise tyre rotation*

Place new tyres on front wheels and change from near to off side or *vice versa* about once in 4,000 miles Use the spare wheel or tyre also in turn, because if you keep it for long periods without use, its life is automatically shortened. Change front wheel tyres to rear wheels after about 15,000 miles (or when about half worn) and again change from off to near side or *vice versa* once in 3,000 miles Change dual tyres as required to give correct pairing in these operations Systematic rotation of tyres will increase average mileage by 25-30 per cent.

To ensure proper matching of dual tyres, which is of prime importance, tyres which differ by more than 0 5 inch in diameter or 0 25 inch in tread thickness, should not be fitted on the same dual wheel Subject to this the more worn cover of the pair should be fitted in the inner position

(6) *Avoid ruts and striking pavement kerbs, bricks and rocks*

(7) *Do not use the steering wheel when the vehicle is stationary If it is absolutely necessary to turn it, get someone to pull the front wheels round by hand*

(8) *Have your brakes, steering gear and wheel alignment examined at regular intervals or after any accident or sudden shock*

(9) *Get increased mileage out of your covers by having them retreaded at the proper time* When the tread is worn smooth, have the tyre examined to see if it should be re-treaded. If this examination is deferred until the canvas shows through the tread, it will be too late

Synthetic Tyres

Synthetic tyres, with which many vehicles now coming into India are equipped, will not stand nearly so much abuse as a natural rubber tyre. The effect of such abuses as speeding, overloading, under-inflation, kerbing and embedded stones, is bad enough on natural rubber tyres but the ruin these abuses bring to synthetic tyres is far more rapid, disastrous and complete

Gas Plant Vehicles

When a gas plant is fitted at the rear of the vehicle, overhangs of more than 45% of the wheel base *including the gas plant* should be avoided and even then it is better to recess the gas plant.

COATING CONCRETE STORAGE TANK INTERIORS

By Lieutenant-Commander CHARLES B TAYLOR
Civil Engineer Corps, U.S Naval Reserve.

IN 1941 the Bureau of Yards and Docks of the Navy Department completed designs and signed contracts for the construction of the Bureau's first prestressed concrete tanks. Prestressed concrete tanks are now being used extensively for the storage of fuel and diesel oil and aromatic gasoline.

As a precaution against leakage, to seal the pores of the concrete and to prevent contamination of gasoline, the tanks are lined, the nature of the lining depending on the fuel stored

Concrete's porosity presented a problem when tanks built of this material were considered for the storage of liquids of low viscosity The Bureau of Yards and Docks did not want to risk the wastage of the lighter oils, such as diesel oil, through lack of an adequate impervious lining Accordingly, the first concrete tanks constructed by the Navy to hold diesel oil were lined with a synthetic resin A silicate lining was used for tanks built to store heavier fuel oils. Both of these materials were said to suit the purposes

More intensive study of types of linings which might be used with gasoline was begun in January, 1942 Improved linings were necessary not only to provide impermeability and thus prevent wastage, but also to keep the gasoline from coming in contact with the concrete surfaces and becoming contaminated. While the contamination problem was not serious with straight cracked gasolines, it was extremely important when the rich aromatic types entered the picture. Studies showed that the alkalinity of the concrete broke down the inhibitors used for stabilizing the aromatic gasolines, thereby causing a serious deterioration of the stored liquid

Aromatic gasolines also brought up another problem in relation to plastic or synthetic types of tank linings, because xylene, toluene, and benzol are solvents for such materials The first part of the problem was to find a lining material which would not contaminate the gasoline or be dissolved by its solvent content The second phase was to develop a method of attaching the new lining to the walls of concrete tanks.

Trial installations of lining whose protective qualities had been approved by the Naval Research Laboratory were made in several of the huge concrete tanks then under construction near Boston Test panels were built and covered with various linings under consideration These panels were subjected to hydrostatic pressure to obtain data on the linings' adhesion qualities and their behavior when in contact with water The linings which made the best showing under these test conditions were selected for permanent installation in the tanks This marked their first use on a large scale

After a year's experience, the Bureau of Yards and Docks is now using sodium silicate as a lining for concrete storage tanks built to hold fuel oil For the lining of diesel oil storage tanks, the Bureau has approved two synthetic resin linings and a Thiokol latex lining Tanks for aviation gasoline are lined with Thiokol latex, Thiokol FA sheet, or synthetic resin linings Each of these linings, while having its relative advantages and disadvantages, has proven to be generally satisfactory

A synthetic resin lining under the trade name of Amercoat, manufactured by the American Pipe and Construction Company, Los Angeles, California, has been applied to a large number of concrete diesel oil and aviation gasoline tanks, and to the interior of 22 concrete ships The other synthetic resin lining approved by the Bureau is manufactured by the A C Horn Co, Long Island City, N Y

For three years prior to the war Amercoat was exposed under Laboratory conditions to 100 octane aviation gasoline At the end of that time there was no change in the gasoline, and the coating still retains characteristic gloss toughness and adhesion

Changes in aviation gasoline after the entrance of the United States into the war resulted in the development of more severe tests The lining was exposed to aviation gasoline made up of 60 per cent 100-octane aviation gasoline, 20 per cent totuol, 15 per cent xylol, and 5 per cent benzol

Results of this test showed that the highly aromatic fuel did not reduce the essential properties of Amercoat, and acted as a plasticizer for the lining, making it somewhat more flexible Extraction tests showed only a negligible amount of residue, too small to contaminate the gasoline

Synthetic resin linings, like each of the other lining materials the Bureau is now using, can be applied to fairly new concrete surfaces, highly alkaline in nature, without the danger of saponifying or losing its adhesion

With water resistance a strict requirement for linings used in the storage tanks, the linings have an extremely low water absorption One test made to demonstrate Amercoat's water resistance and its adhesion to concrete was to make a stack of porous concrete pipe 22 ft. high, apply the coating to the exterior of the pipe, and then fill the pipe with water, making a pressure at the bottom of the column of approximately 10 p s i This column was kept filled with water for six months At the end of that time, the coating showed no loss of adhesion nor was there any penetration of the water through the lining

Synthetic resin linings can be applied by ordinary painters with standard spray painting and ventilating equipment or may be brushed on It requires a completely dry, clean concrete surface, and care must be taken in the application of each coat to see that there are no pin holes The chief disadvantages of Amercoat as a lining for fuel storage tanks are relatively poor elasticity and the necessity for applying a

Concrete ships lined with "Thiokol" synthetic latex are the latest solution to the problem of transporting vast quantities of aviation gasoline to strategic coastal points and military bases Since the alkalies in concrete deteriorate the inhibitors in gasoline, permit gum to form, and lower the octane rating, the "Thiokol" lining is necessary to protect the gasoline These ships are constructed with steel bar stock which is less critical than the steel plate used in all-metal vessels, and require far less manpower in building than either wood or steel ships

Workmen applying Thiokol primer coat around column base and on floor of gasoline storage tank

large number of coats Adequate ventilating equipment is essential and is specified by the Bureau to eliminate the hazard of explosions which can occur with concentration of the vapours during application

Another lining used by the Bureau is Thiokol FA sheets—thin sheets of synthetic rubber which are applied to walls, floors, and columns like wallpaper Thiokol FA sheets reduce the loss in octane rating and the formation of gum in the gasoline caused by aromatic gasolines in direct contact with concrete, and prevent loss of fuel by seepage

Thiokol sheeting was developed and manufactured for the Bureau by the Boston Woven Hose and Rubber Company of Cambridge, Mass after considerable experimentation The synthetic sheet consists of a high density sheet of the Thiokol FA—a polysulfide synthetic rubber which may also be used for the fabrication of hose and other solvent-resistant specialty products The sheets used in tank construction are required to be made in two thicknesses 0 025 in for side-walls and columns, and 0 030 in for floor coverings The sheets are 38 in wide and made in 100-yd rolls The front surface is smooth, except for a 3-in strip along one side, which, like the back surface, is rough to provide better lap adhesion

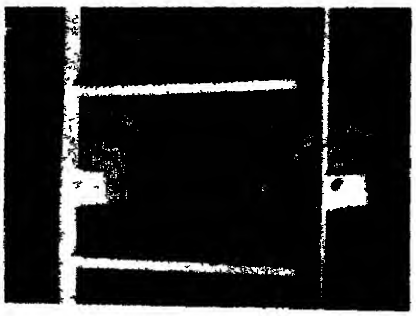


Photo Courtesy Bureau of Yards and Docks

Even the columns of the concrete underground tanks now used by the Navy for storing aviation gasoline, when synthetic sheet linings are used, are covered with sheets of Thiokol FA material to keep the gasoline from coming in contact with free alkalies in the concrete – which would lower its octane rating

Production of the lining involved several new fabrication problems After the crude stock is mixed in a Banbury mixer, it is calendered into sheets and wound in rolls, with an interliner to prevent sticking Without removing the interliner, the sheets are air-cured for 15 minutes at 320 deg F The interliner is then removed and the sheet is fed into a continuous curing press This process, which takes about two minutes, gives the sheeting its high density and strength characteristics The final step is buffing and measuring, followed by inspection over a light box. Every foot of the material is so inspected, since the slightest pin-hole would permit gasoline to come in contact with the concrete

Installation of the Thiokol FA lining in many ways resembles the hanging of wallpaper. Actually it is a far more complicated operation

After all holes have been filled and all projections removed from the concrete surfaces, walls columns, and floors are coated with a special synthetic rubber cement applied with a notched trowel. After this has dried thoroughly, a second coat is applied immediately to the portion of the wall which is to be lined and to the back of the Thiokol sheets

The only adhesive that has been developed that will give the required bond between concrete and the sheets contains Hycar, a highly critical material During the lining programme much difficulty was experienced by the Navy in getting releases for sufficient Hycar to carry out this work and at present none of this material is available for commercial use. It is to be noted that while water has no ill effects on the adhesive cement after it has cured, the adhesive cement will not set in the presence of moisture and great care must be exercised to obtain absolutely dry concrete while applying and until the cement has thoroughly cured

Ventilators are then set up to exhaust the solvent from the cement as these fumes are toxic and inflammable When the strip of lining reaches just the right stage of tackiness, it is hung in a manner similar to a strip of wallpaper, starting at the top and allowing a 6-in. overlap onto the floor

Great care has to be taken to prevent the sheet from coming into contact with the wall out of place since the adhesion of the cement is so great that it is almost impossible to unstick it once it is stuck. The sheets are brushed into contact with heavy brushes to insure perfect adhesion at all points

After the walls are covered, areas around ladders, pipes and other protuberances are carefully patched so that not one square inch of the bare concrete is left exposed The concrete columns supporting the roof are then similarly covered

Final Step

The final step is covering the floor A slightly thicker Thiokol sheeting is used on the floor because of possible damage by men working in the tank Instead of running strips all the way across the bottom of the tank, pieces of not more than 10 ft in length are patched together in the manner of flooring to insure a perfect fit around the base of the columns A 9-in strip then is superimposed on the joint where the walls meet the floor

In addition to providing resistance to aromatic gasoline and the water which is bound to collect in the bottom of the tank, Thiokol FA sheeting has the added advantage of forming a container which remains leakproof even in cases where the concrete wall cracks due to stresses, ground shifts, or temperature changes, due to its strength characteristics

The third type of lining for gasoline tanks, Thiokol latex, does not have the strength characteristic or the controlled thickness which is obtainable with the Thiokol sheet material This is also true of the synthetic resin linings, but has

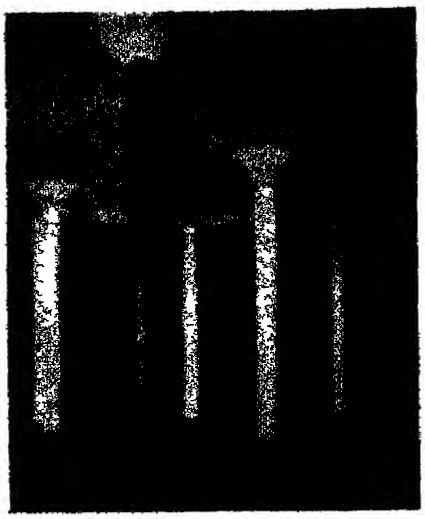


Photo Courtesy Bureau of Yards and Docks

Special care has to be taken to patch around ladders and other projections since any contact between aviation gasoline and the bare concrete would result in a chemical reaction as well as possible leakage The Thiokol FA lining with which the walls are covered is completely resistant to oil and gasoline.

proven, entirely satisfactory as a coating when properly applied Thiokol latex compounds are manufactured for the Bureau of Yards and Docks by Stoner-Mudge, Inc, Pittsburgh, Penn

To overcome the objection due to lack of strength characteristic, Stoner-Mudge Inc developed a reinforcing membrane which gives the lining a satisfactory crack bridging quality This membrane-reinforced Thiokol lining was approved by the Bureau and has been used on all but the first few tanks lined for the Navy using Thiokol latex compounds

The standard method of application after proper preparation of the concrete surfaces is as follows One coat of primer is applied by calsomine brushes and allowed to set, and then a second coat of primer is applied and the dampened fabric or membrane is immediately applied, smoothing it on with a dry brush This fabric is a 4-oz Osnaburg cloth with a thread count of 26 × 26 No cloth having a weight of less than 3 5 oz or a thread count of over 32 × 32 is permitted Two more coats of primer are then applied allowing each coat to set Two coats of finish are then applied The finished lining is 0 030 in thick with a tolerance of minus 0 005 in A third finish coat may be required to obtain the minimum thickness required

This type of lining has been eminently satisfactory and has the advantage of being as economical in cost as the synthetic resin linings, and is in effect, a built-in-place sheet having strength necessary for bridging cracks similar to the Thiokol FA sheets

Navy Tests

In tests conducted by the Naval Research Laboratory (Anacostia Station), Washington, D C, Thiokol latex proved completely water resistant, and gum formation (effect of liner on water) was 1 4 mg compared with 20 7 mg for Amercoat in the same series of tests Gum formation for Thiokol FA sheets was nil pH of water after ten days contact was 7 5 during the test period compared with 7 0 for Thiokol FA sheets and 8 4 for Amercoat

For the successful application of any of the approved types of linings, the Bureau specifications for the concrete tanks must be rigidly followed Before application it must be positively assured that the tanks are leakproof, and repaired where any leaks or seepages occur Unfamiliarity with the principles of prestressed reinforced concrete tank construction and speed of construction at the expense of quality caused much difficulty in the early periods of the programme The necessity of a smooth concrete surface free of fins, projections, or holes over ⅛ in in diameter is paramount in obtaining good adhesion of the linings

Much credit for the ultimate success of the tanks lined for the Navy is due to the co-operation, development work, energy, and efficiency of the manufacturers of the materials used, and to the research work conducted by the Naval Research Laboratory including testing of the many types of linings submitted before the three types of linings were finally approved for Navy use

All three linings have contributed greatly to the Bureau's successful development of concrete storage tanks These new tanks not only represent a vast saving in vital steel plate but offer the added advantage of being practically invulnerable to fire from normal operational hazards and because of concealment and disposition reduce possible losses from bombing attacks —(*With acknowledgements to 'Concrete'*)

FLOATING CONCRETE BRIDGE AT HOBART

ALTHOUGH the floating bridge is one of the oldest methods of carrying a road across a waterway, the floating concrete bridge recently completed to span the River Derwent at Hobart, Tasmania, by no means adheres to conventional ideas It is, in fact a highly ingenious piece of work and a notable bridging achievement In the first place, it is not carried straight, across the river, but follows a circular arc with its convex face presented upstream It may, therefore, be compared with an arched bridge laid on its side the loading carried by the deck of the normal bridge being represented in the floating bridge by the pressure of the downstream flow The result in both cases is, however the same, the curved member being in compression The resemblance to an arched bridge is increased by the fact that the two main sections of which the floating bridge is composed are joined together at the centre by a pin, while what may be called the abutments have analogous pin connections The city of Hobart is situated on the west bank of an estuary and is faced on the east bank by a suburb Bellerive The bridge connects the two places, and, apart from road traffic, will, in the near future, carry a water main to improve the supply at Bellerive

The River Derwent is navigable for some distance up, and accordingly passage through the floating bridge has been provided for by a high-lit bridge at the Hobart bank The total length of the bridge, including the lifting span and approaches, is 4 000 ft, the actual floating roadway being 3 168 ft in length This roadway consists of 24 reinforced concrete pontoons connected rigidly together in two sections, of 12 pontoons each, the sections being connected at the centre by a single pin, 13 in in diameter The freeboard of the pontoon parapet is 4 ft 0 in, but the parapets will be deepened and finished by a lighter structure, the top of which will be 9 ft above the water level, which should give ample protection from spray in the worst weather The pontoons are 40 ft in width this dimension providing a roadway 30 ft wide, a footway 6 ft wide, and sufficient space for the installation of the water main referred to above The road surface is continuous, since the pontoons have not individual freedom of movement The depth of the pontoons is 10 ft and each weighs rather more than 1,000 tons The anchorage at the abutments consists of a deep steel box girder, triangular in plan, the base of the triangle lying along the end of the floating structure, and its apex being at the abutments The girder is coupled to the pontoons and abutment by heavy steel pins, the construction forming a hinged connection which allows for vertical movement with the rise and fall of the tides

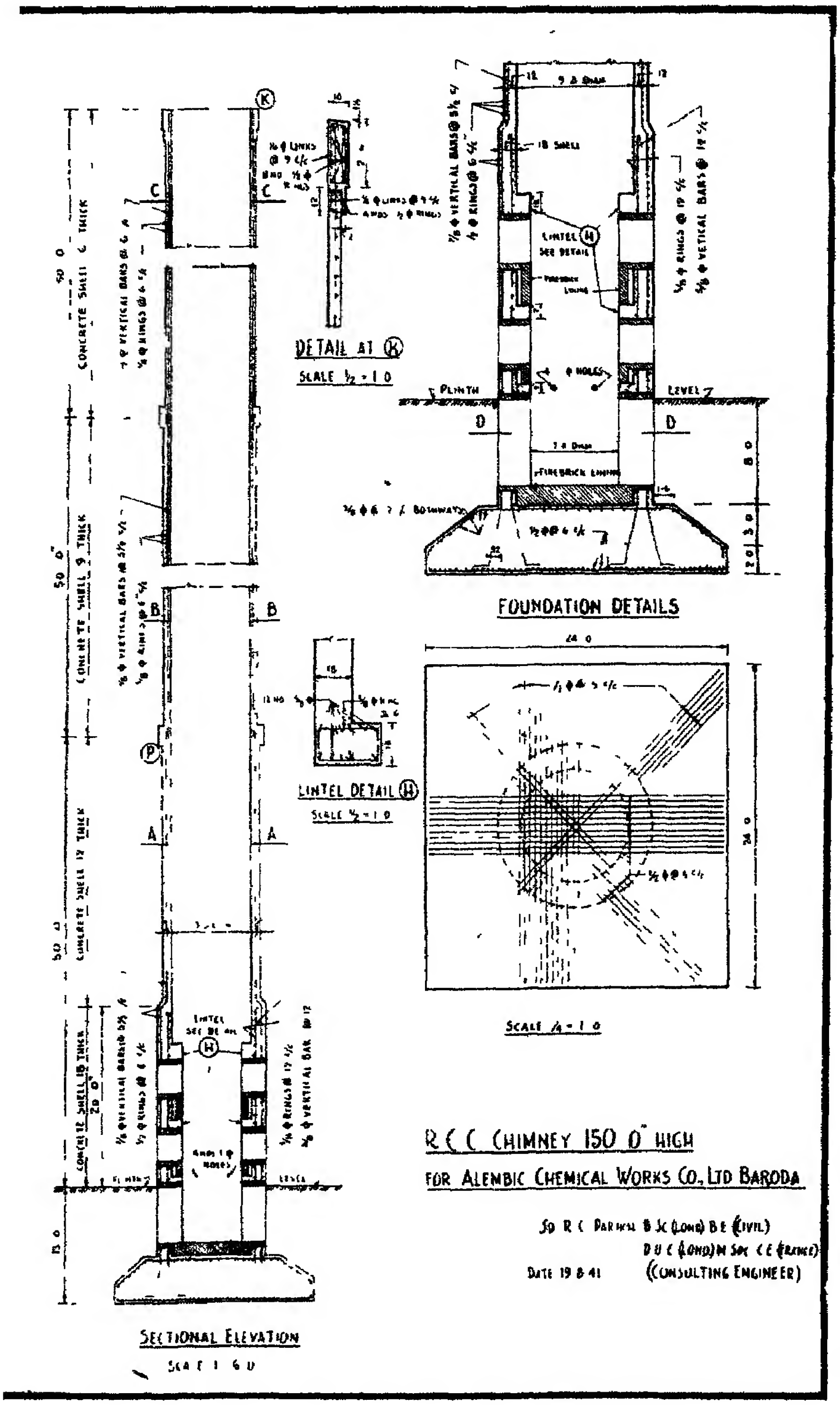
The abutment on the Hobart bank is on a heavy reinforced concrete pier, which forms the base for one of the towers of the lifting span, this pier standing in the stream The corresponding pier for the other tower is closer to the bank to which it is joined by the approach span The lifting span bridge follows more or less conventional lines It is wholly of steel, the towers being of the open braced-frame type and the span itself being of a modified deep Warren girder design The installation of the floating bridge was a somewhat difficult undertaking as may well be imagined, when it is considered that two floating structures, each 1 584 ft long measured along the arc had to be towed to the site manoeuvred into place in a current, and joined together in mid-stream Each part was, of course rigid the component pontoons having been assembled in a bay of the estuary downstream from the bridge site The ends of the bridge through which the coupling pin passed were first attached to a moored buoy in the centre of the river so that they could be turned as if on a central hinge, into correct alignment The sections being thus anchored at the centre, the shore ends were gradually towed round and secured to the abutments The final stage was the closing of the gap near the moored buoy and insertion of the pin

The new bridge was designed by Mr A W Knight, chief engineer of the Public Works Department of Tasmania The provision of the bridge was undertaken by Messrs Hobart Bridge Co, Ltd, which obtained the right from the Tasmanian Government to collect tolls The actual building was first entrusted to a private firm but the work was subsequently taken over by the Public Works Department, with Mr J A Slatter as resident engineer. —(*The Commonwealth Engineer*")

150 FEET HIGH REINFORCED CONCRETE CHIMNEY AT BARODA

Designed and Supervised by **R. C. PARIKH, B.Sc. (Lond.), B.E. (Civil), D U C (Lond), M.Soc. C.E. (France).**

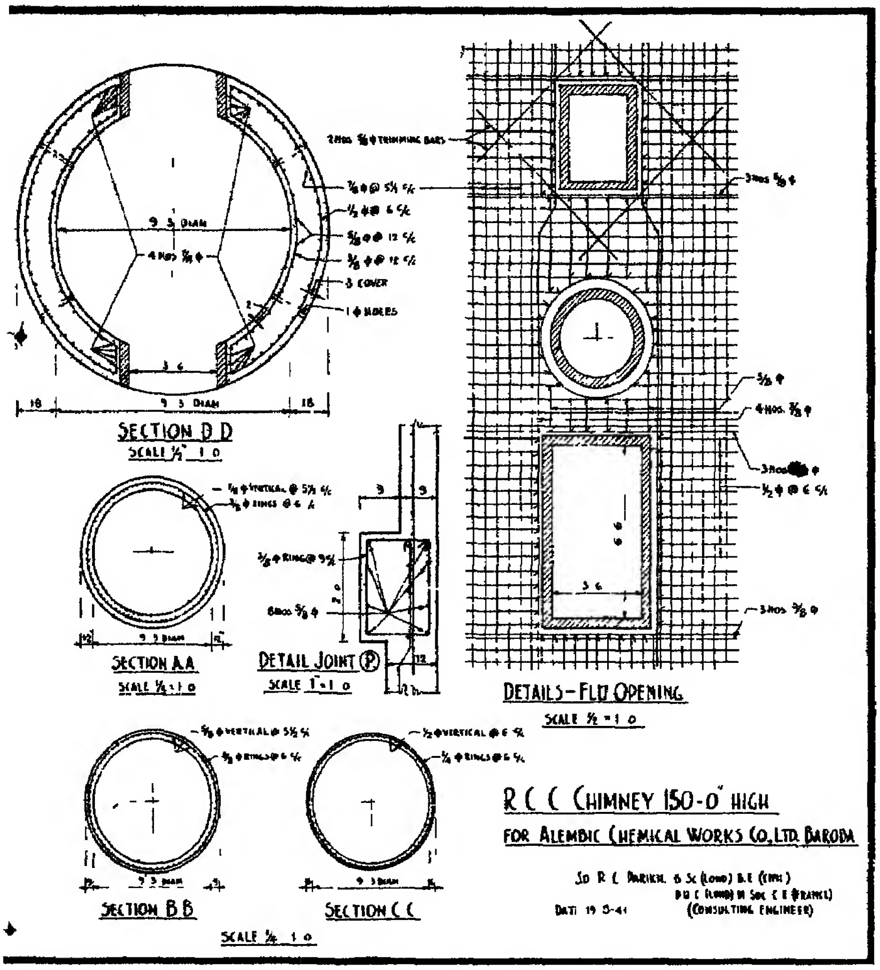
IN the year 1941 the Baroda Alembic Chemical Works Co Ltd decided to provide a power plant to cope with the increasing demand on their industry Mr Ramanbhai B Amin, the General Manager decided to build the whole plant in modern methods after the models of those in European countries, where, particularly in Germany considerable time was spent by him in studying the latest methods in engineering practices The whole building work was to be done in very short time, and it is interesting to note that the work of the entire reinforced concrete chimney was completed in seven weeks



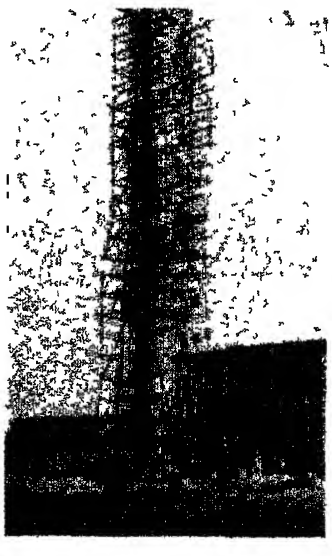
At first it was decided to build a chimney of 120′ height Later on the height was increased to 150′ The designs were made for a chimney of 150′ height

The designer had in mind the cases of various reinforced concrete chimneys that had later on cracked As such great care had to be employed both in the design the concrete mix, and the entire construction A firebrick lining with a 4″ air gap in the chimney was at first proposed Another proposal was to use asbestos powder in the mix of the concrete shell, along with an inch thick cement plaster mixed with asbestos powder all along the inner surface of the shell There were no available datas to find out the actual effect of the use of asbestos powder in cement mix, so far as the ultimate effects for obviating cracks due to heat, etc were concerned There was another aspect to be considered from the point of view of the General Manager The use of fire bricks for inner lining would mean not only considerable expense but also considerable time that would be required in ordering and getting special bricks etc It was therefore decided, thanks to the bold decision taken by Mr Ramanbhai B Amin, the General Manager that for the time being only asbestos powder mixed cement concrete should be used, and later on to provide silica brick lining if it was found absolutely necessary It is over three years since the chimney was constructed, and as no cracks have developed no silica brick lining has been provided

In Baroda we come across black cotton soil almost everywhere As such the foundations had to be taken below this soil A good uniform bed was reached at a depth of 13′, and it was decided to build the chimney foundation on this soil A reinforced concrete base of 24′ × 24′ was provided The thickness of the base was kept 5′ in middle, reducing to 2′ at ends The concrete mix in the foundation was in the proportion of 1 2 4 The aggregate consisted of quartz pebbles graded from 1¼″ to ⅛″ The aggregate was specially selected and collected from a river bed near Vasad about 20 miles away from Baroda The sand was obtained from the same river It should be noted here that both the aggregate and sand were considerable superio to the usual trap aggregate and sand used in and around districts of Bombay



The inside diameter of the chimney is actually 8′ without any firebrick lining The concrete mix in the chimney shell is in proportion of 1 1½ 3 The shell thickness from foundation base was kept 18″ up to 20′ above ground level, and then reduced to 12″ up to 50′ height from ground level For next 5 ′ height 9″ thickness of shell was provided and for the top 50′, 6″ thickness of shell was provided Shell portions where the thicknesses were reduced, were provided with extra reinforcement so as to form a sort of circular beam



Under construction

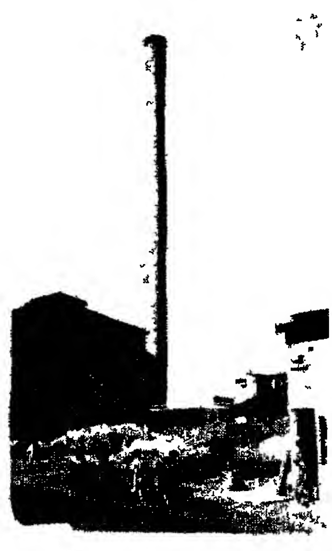
Centering consisted of steel plates bent exactly to the curved shape of the shell As the work was very urgent, the centering was to be so devised as to be easily removable and quickly reassembled, bearing in mind the absoluteness of the plumb The steel plates were 4′ high and only 4′ of the shell height was filled at a time The inside formwork of the steel plates—consisting of four curved steel plates—had to remain the same throughout The outer formwork of steel plates—consisting of four steel plates—had to be altered only twice The four feet height of the steel formwork was easy to be handled At every filling of 4′, few hollow steel pins were embedded in concrete about 3″ below top portion of concrete to be filled To this the centering plates were bolted when carried up This turned out to be easily manageable with the result that concreting of 4′ height of chimney shell was carried on almost daily Unfastening of centering plates and carrying of these up and refixing the same by bolts to pins provided below was a job of less than half a day The pins were left embedded in concrete and later on filled in with cement grout when not required They were at first proposed to be used for fixing clamps for providing a sort of ladder up to the top of chimney The factory Engineer Mr Shankarbhai Patel was specially in charge of this work as all along we had to be very careful about plumb

For heat-proofing the chimney as explained above we used asbestos powder in the 1 1½ 3 mix of the chimney shell About 2 5 lbs of asbestos powder was used on 100 c ft of aggregate We had in mind to provide 1″ thick cement plaster mixed with asbestos powder to the inner surface of the shell at least up to a height of 50′ But later this idea was dropped This would undoubtedly have been an added precaution against formation of cracks The fact that after three years we do not find development of any cracks bears a good testimony to the efficacy and utility of mixing asbestos powder in concrete mix

We had to provide six openings at base of the chimney for flues and arrangement for forced draft provision in future Special reinforcement was provided around these openings as the effective area of the shell was reduced at these openings

Under the personal direction of Mr Ramanbhai B Amin the General Manager the work was so economically promptly and ably carried out that the cost actually came much below that for a brick chimney The actual cost was somewhere about Rs 14,000 Steel and cement were obtained at controlled rates, and local workmen were employed

The total quantity of 1 2 4 concrete in foundation was 2650 c ft and that of 1 1½ 3 concrete in chimney shell was 2200 c ft



Completed.

ROADWAY SURFACING AT ST. PETERS, S.A.

By F. W. SYMONS, B.E., F.S.A.S.M., A.M.I.E. Aust.

FOLLOWING upon the publication of an article in the February 1943 issue of the "Constructional Review" relative to the resurfacing of bituminous roadway pavements with a cement grout by the Queensland Main Roads Commission, the St. Peters Council authorised its Engineer to carry out similar work on the sides of one of its suburban streets. This class of work was carried out more as an experiment to test the wearing qualities of the fine concrete under vehicular traffic and also to ascertain how it withstood the climatic conditions experienced in Adelaide and its suburbs. The Government Meteorologist (Mr. E. Bromley) kindly supplied the following information in respect of temperatures recorded in Adelaide during the past ninety years:

Maximum sun temperature on record	180.0 deg.
Maximum shade temperature on record	117.7 deg.
Minimum shade temperature on record	32.3 deg.

Shade Temperatures in Screen

Extreme variation in 24 hours in Summer:

49.1 degrees from maximum of 107.8 degrees at noon on 22.1.35 to minimum of 58.7 degrees at 6 a.m. on 23.1.35.

Extreme variation in 24 hours in Winter:

28.2 degrees from maximum of 70.1 degrees at 1 p.m. on 9.7.33 to minimum of 41.9 degrees at 5 a.m. on 10.7.33.

Extreme weekly variation in Summer:

65.7 degrees from minimum of 43.0 degrees on 4th to maximum of 108.7 degrees on 9th December, 1906.

Extreme weekly variation in Winter:

43.5 degrees from maximum of 75.8 degrees on 12th to minimum of 32.3 degrees on 17th August, 1859.

Tests were made in India some years ago as to the temperature of exposed metal rails laid on the ground. It was found that on the average the rails during the day were 25 to 30 degrees above the shade readings, but were 3 to 5 degrees below the screen readings at night. The sun temperature in summer is usually approximately 50 deg. F. more than the shade temperature. The variations of temperature during the week ending 9th December, 1906 were as follows:—

Date	Maximum Temperature Sun Temp.	Maximum Temperature Shade Temp.	Minimum Temp.
3rd Dec. 1906	126.5	71.0	54.0
4th Dec. 1906	124.0	70.0	43.0
5th Dec. 1906	135.0	84.3	47.9
6th Dec. 1906	147.2	98.4	60.6
7th Dec. 1906	150.1	103.0	67.7
8th Dec. 1906	153.2	108.7	67.9
9th Dec. 1906	161.0	108.0	79.0

Method Used in Carrying Out the Work

The sides of the roadway were thoroughly cleaned with a rotary broom and then hosed in order to remove all deleterious matter which would tend to prevent the thin concrete surface from adhering to the old bitumen penetration base course. Immediately the surface was washed down and whilst still damp a layer of neat cement was spread evenly over the surface at the rate of 3.4 lb. per square yard. This was broomed into the surface of the existing bituminous penetration roadway to provide a suitable tack coat between it and the concrete surfacing. Whilst the tack coat was still wet a layer of finely graded concrete comprising equal parts of cement, sand, and finely graded coarse aggregate, by volume mixed in a small power driven concrete mixer was placed on the pavement and screeded off using rubber squeegees with long handles. Just sufficient water, viz., 6 gallons per bag of cement, i.e., W/C ratio of .96 by volume, was added to obtain a workable concrete mixture. Sieve analyses of the fine and coarse aggregates are tabulated hereunder:

(1) Sieve Analysis of ⅜in. Quality Screenings.

	Percentage Retained	Cumulative % Retained
Passing 4 mesh and retained on 8 mesh sieve	30.0	30.0
Passing 8 mesh and retained on 14 mesh sieve	53.4	83.4
Passing 14 mesh and retained on 30 mesh sieve	7.5	90.9
Passing 30 mesh and retained on 50 mesh sieve	3.3	94.2
Passing 50 mesh and retained on 100 mesh sieve	2.5	96.7
Passing 100 mesh	3.3	100.0
Total	100.0%	

Fineness Modulus 3.95

(2) Sieve Analysis of Washed River Sand

	Percentage Retained	Cumulative % Retained
Passing 4 mesh and retained on 8 mesh sieve	10.0	10.0
Passing 8 mesh and retained on 14 mesh sieve	12.5	22.5
Passing 14 mesh and retained on 30 mesh sieve	36.7	59.2
Passing 30 mesh and retained on 50 mesh sieve	35.0	94.2
Passing 50 mesh and retained on 100 mesh sieve	5.0	99.2
Passing 100 mesh	.8	100.0
Total	100.0%	

Fineness Modulus 2.85

The proportions of screenings and washed sand were determined from the following formula:—

$$P = 100\frac{A-B}{A-C}$$

Where P = Percentage of fine aggregate (sand) in the total mixture of (1:2).

A = Fineness Modulus of coarse aggregate (⅜in. screenings).

B = The Fineness Modulus of the Final Mixture (taken as 3.40 for a 1:2 Mortar).

C = Fineness of Modulus of washed river sand.

$$\text{Then } P = 100\,\frac{(3.95-3.40)}{(3.95-2.85)} = 50\%$$

The mixture adopted for the work using equal parts of ⅜ in. screenings and washed river sand was found to be satisfactory.

Itemised costs are summarised hereunder:—

Personnel:

1 Ganger, 1 Truck Driver, 2 Labourers.

Items of Plant:

Rotary Broom (drawn by Truck).
Small Power Driven Concrete Mixer.
One 30 cwt. Truck with gas producer attached.

Cost of Work :

Area 1,250 square yards.

	Total	Cost per sq yd in pence
Labour	£11 17 0	2 27
Materials	26 14 8	5 13
Stores	0 16 3	16
Plant Hire	0 11 6	11
Totals	£39 19 5	7 67

Itemised Cost Per Square Yard :

Nature of Work	Labour	Materials	Stores	Plant Hire	Tota
Brooming and Washing	20		09	04	33
Neat Cement Tack Coat	20	1 60			1 80
Concrete Surfacing	1 57	3 13	07	07	4 84
Sanding and Curing	20	36			56
Lighting and Barricades	·10	04			14
Totals in pence	2 27	5 13	16	11	7 67

Labour Rates :

Ganger, 2/9½ per hour
Truck Driver, 2/7½ per hour
Labourers, 2/5 per hour

Materials :

102 bags cement @ 3/9	£19 2 6
5 tons ¼in screenings @ 13/9	3 8 8
5 tons washed river sand @ 8/6	2 2 6
5 tons 10 cwt unwashed quarry sand curing @ 6/8	1 16 8
3 galls lighting kerosene @ 1/5½	0 4 4
Total	£26 14 8

Quantities Materials Per Square Yard.
Tack Coat :

Cement, 3 4 lbs
Water, 4 35 lb, *i e*, 12 gals per bag cement

Surface Coat :

Cement, 4 3 lbs
¼ screenings, 9 0 lb
Washed river sand, 9 0 lb
Water, 2 8 lb, *i e*, 6 gals per bag cement

Stores .

Concrete Mixer—Petrol	7/3
30 cwt Truck—Charcoal	5/3
Petrol	3/9
Total	16/3

Plant Hire :

Concrete Mixer—12 hours	7/6
30 cwt Truck	4/-
Total	11/6

The day after the surfacing was completed it was covered with a thin layer of unwashed quarry sand This was allowed to remain and after six (6) months a small quantity was still on the sides of this street The surfacing at the present time is in excellent condition and no cracks or defects have appeared It might be added that during the progress of this work light showery weather was experienced which helped to create suitable conditions for the carrying out of such work. This surfacing work will be carefully watched with the view to ascertaining how it will withstand vehicular traffic and weather conditions, especially during the summer months when the temperature will be likely to rise on many occasions to well over 100 deg F Should this experiment prove to be quite satisfactory, which the writer feels confident it will then no doubt the Council will carry out additional lengths of this particular type of work in the near future

Top Dressing Footpaths using a Cement-Unwashed Sand Admixture.

It has been the practice of the St Peters Council, and many other Councils, for that matter, to surface its earth footpaths, or when old and worn asphalt has been removed from same, with a thin layer of sand and later cover such footpaths with small sized screenings Although this practice appears to be generally satisfactory in the summer months, it is not very acceptable in the winter or in wet weather Such paths were continually being screened, especially following heavy rain in the winter months The Engineer was authorised to top dress two footpaths within the Municipality in the following manner

After regrading the footpaths to a reasonable crossfall and gradient, using a fine rubble-blinding where necessary, a layer of premixed unwashed quarry sand with 10 per cent cement by volume was spread over the footpaths to a depth of approximately one and a quarter inches (1¼in) After screeding the loose sand-cement top dressing to the desired level it was immediately sprayed with water, in sufficient quantities to enable such water to percolate to the underside of the top dressing In one footpath the sand-cement and water were mixed in the Council's 600 lb batch paddle mixer and of course a much more even mixture was obtained After spreading, the layer was then given a preliminary rolling using a fifteen (15) cwt hand roller and next day was again rolled, using a twenty-five (25) cwt roller The lengths of footpaths in question were treated in this manner approximately four (4) months ago, and are at present in excellent condition

The result of a sieve analysis of the unwashed quarry sand was as follows —

	Percentage Retained	Cumulative % Retained
Passing 4 mesh and retained on 8 mesh sieve	5 0	5 0
Passing 8 mesh and retained on 14 mesh sieve	22 5	27 5
Passing 14 mesh and retained on 30 mesh sieve	50 8	78 3
Passing 30 mesh and retained on 50 mesh sieve	18 3	96 6
Passing 50 mesh and retained on 100 mesh sieve	1 7	98 3
Passing 100 mesh	1 7	100 0
Total	100 0	

Samples of the sand were forwarded to the Adelaide University for testing and the graphs shown in Figure were prepared from the results of these tests Standard size Proctor cylinders of unwashed quarry sand and cement with 12 per cent water content were moulded and the usual wet-dry tests were carried out, together with compression tests at seven (7) days on similar cylinders containing 6, 8, 10 and 12 per cent cement respectively

See Graph

From these graphs it was considered that it would be economical to use 10 per cent cement in the top dressing

The cost of surfacing one of the footpaths in this manner is summarised hereunder together with the number of men engaged on the work, and the items of plant used

Personnel :

1 Ganger and Truck Driver
3 Labourers

Cost of the Work

Area 660 Square Yards

	Total Cost	Unit cost per sq yd in pence
Labour	£15 15 2	5 6
Materials	10 4 0	3 7
Stores	0 15 4	3
Plant Hire	0 9 3	2
Totals	£27 3 9	9 8

Itemised Cost :

Labour—

Asst Ganger and Truck Driver	2/7½ per hr
Labourers (3)	2/5 per hr

Details of Cost :

Labour—

	£	s.	d.
26-2/5 man-hours @ 2/7½ (Asst Ganger) .	£3	9	11
101-3/5 man-hours @ 2/5 (3 labourers) .	12	5	3
	£15	13	2

Materials—

	£	s.	d.
30 bags Cement @ 3/9	£5	12	6
5 cwt Red Sand @ 6/- per ton . ..	0	1	6
13 tons 10 cwt unwashed Quarry Sand @ 6/8 per ton	4	10	0
	£10	4	0

Quantities of Materials per sq. yd. of Footpath :

Cement, 4·3 lb.
Unwashed Quarry Sand, 46 lb

Stores :

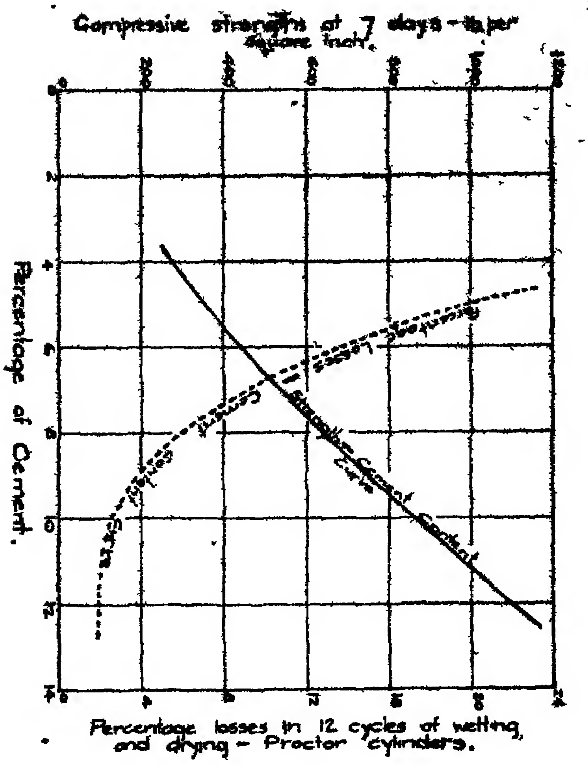
30 cwt Truck—Petrol, 15/4.

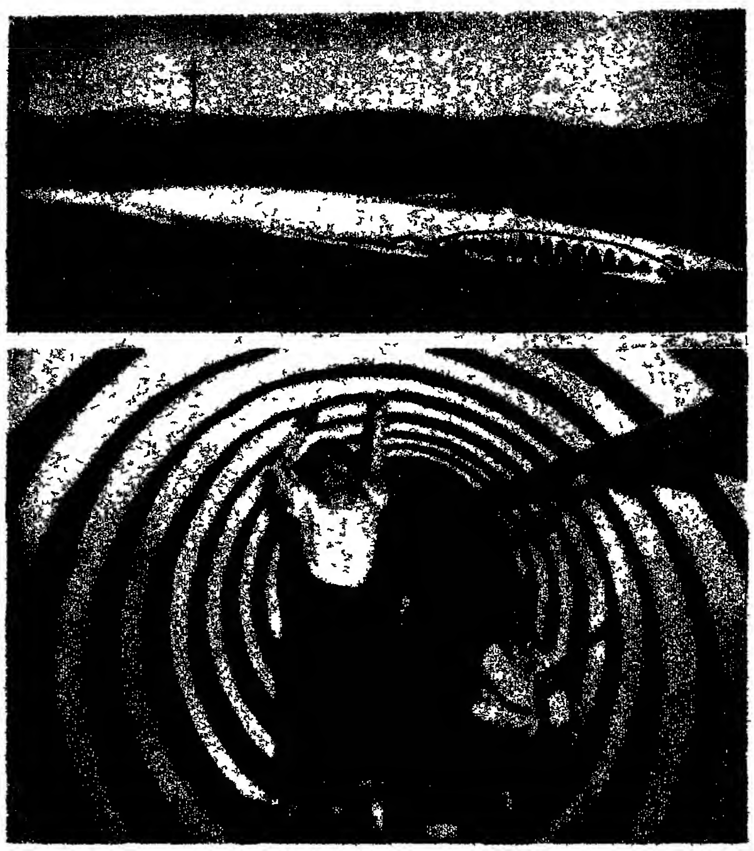
Plant Hire :

30 cwt Truck, 9/3

Conclusion.

The two projects described herein were carried out mainly as experiments to test the qualities of various local materials under ordinary suburban traffic, and to see how they withstood the extreme variations of temperature and prevailing climatic conditions experienced in Adelaide, especially during the summer months —(*With acknowledgments to " Constructional Review "*)



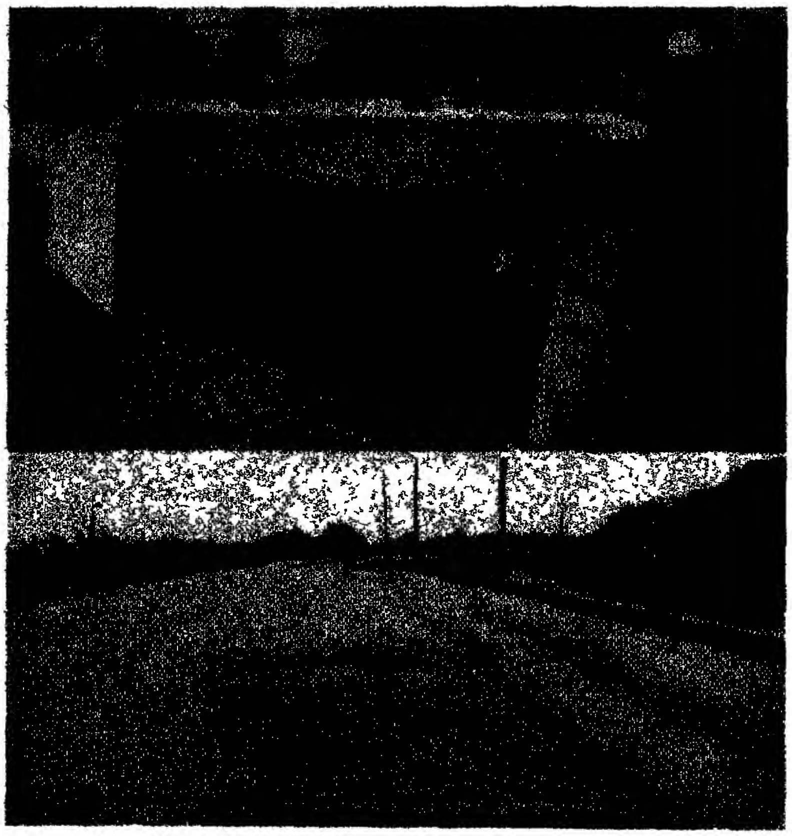


CONCRETE "SUBMARINE"

Old-time Mariners probably rubbed their eyes in disbelief when they saw the Lektron plowing through the water on a test run in San Francisco harbour. As shown in the illustration the boat is a 125-ft., 11-ton model of a 10,000 ton cargo ship. Designed by Hal B. Hayes, the model cost £80,000, and is powered by two V-8 motors It is cigar-shaped and is built entirely of reinforced concrete. The ship looks and rides like a submarine, and it has no keel, but it is not yet designed for submerging.—(" Rock Products.")

CONCRETE SURFACE-PATCHED WITH PRESSURE-VIBRATED MORTAR

By ROBERT E. WILLEMS,
Division Engineer, District 12, Ohio Department of Highways, Cleveland, Ohio



Extensive area on bridge shown after completion of resurface The thin layer of compacted mortar could be walked on immediately, was opened to traffic in approximately 10 hours (Upper view) Vertical structural surface after patching with method described below

THE Cleveland division maintenance forces of the Ohio department of highways have recently completed concrete repairs with a method of skin patching local pavement areas scaled from excessive use of chemicals used for ice control

One instance was the resurfacing of a concrete bridge deck on Bulkley Boulevard in Cleveland The scaled surface was taken down about 1½ inches with pneumatic pavement breakers The exposed rough surface was then blown free of dust and small particles, and lightly sprinkled, taking care that no free water pockets formed Mortar was then applied, consisting of a 3½ gallon, 1-2 mix using a sharp, coarse plaster sand The mortar when put down was dry enough to just border on the crumbly stage and be fairly workable under vibration The mortar was first vibrated on the old concrete, to form a bond between the old and new concrete, then additional material added, the vibrator was mounted on a steel strike-off screed to simultaneously vibrate and finish the new surface to the required grade The vibrating equipment used was developed by a Cleveland manufacturer (The International Vibration Company) The unit is controlled by handles as shown in the accompanying illustration It applies pressure combined with rotary horizontal (not vertical) vibrations at approximately 7,000 R P M, and is driven by an air motor The bottom of the vibrator is tapered front to back, the front or receiving end being of greater capacity, acting as a throat which compresses the concrete under vibration as the unit moves forward

On Bulkley Boulevard, Cleveland. Scaled areas were dug down, loose material removed, surface blown clean of dust and small particles.

Mortar was placed on small areas to be re-surfaced and "bonded" in by means of the vibrator shown.

Two stages in use of vibrator—first as a "bonder," then in conjunction with hand-drawn screed

Samples of mortar resurface thus placed, when later taken out of the pavement, showed that a practically perfect bond is obtained by the above method. The new surfaces have shown satisfactory wearing qualities under the extremely heavy traffic on Bulkley Boulevard (25,000-30,000 vehicles daily) Some patches were made with vinsol resin cement, others with normal portland cement The patches made with normal cement have shown higher resistance to concentrated chemical applications than is ordinarily expected of such concrete, a quality apparently due to the low water-cement ratio and superior density of the patches

Because of the compaction and early strength obtained, the patched areas could be walked on immediately without shoe imprint, and were opened to traffic in approximately ten hours

Application on Bridge Walls and Other Vertical Surfaces

A similar but smaller model vibrator furnished by the same manufacturer was employed to repair the outside face of deck slab and abutment surfaces of a small concrete bridge on which the concrete surface had deteriorated

The vibrator unit used here has an area of 6 by 20 inches, and is made up largely of magnesium parts in order to make it light enough for use by a single workman as a power trowel. Vibrations are obtained through an unbalanced air turbine, built into the body of the vibrator and operating at 10,000 R.P.M

The procedure here was to remove all loose particles with small pick hammers, then a thin layer of mortar was vibrated into the rough, irregular surface of the old concrete, passing the vibrator over several times Then if greater depth of mortar was needed to restore the original surface, additional material was placed and the surface built up without or with partial forms vibrated from the outside

Initial application and vibration of the first thin coating is the most important part of the procedure, as it is at this point bond is formed between the old concrete and new surface

If a full $1\frac{1}{2}$ inch or 2 inch thickness is applied in one application, the compacting and bonding effect of vibration under pressure is lost due to the depth of plastic materials which cushion the vibrations

Repairing Blow-ups

A larger than average number of pavement blow-ups have occurred this year in Ohio Division 12 area In several cases blow ups have been repaired as follows First the old concrete was cut out on a straight line on either side of the blow-up area, and piled at the side Next the chunks of old concrete were placed on the sub-grade, the larger chunks to the bottom, and a 1-2 mortar vibrated into the mass The vibrator is then mounted on a strike-off screed and the top of the repair struck off under vibration to the level of the adjacent concrete road

The foregoing work was carried out under the author's directions by H H Palmer, Division Maintenance Engineer at Cleveland, and M J Schneider, Maintenance Superintendent, Cuyahoga County H D Metcalf is Chief Engineer, Bureau of Maintenance, H. G Sours, Director of Highways —(*With acknowledgments to " Roads & Streets "*)

Blow-up repaired by re-use of concrete fragments, grouting over, and finishing with Pressure-Vibrator and screed

CONTRIBUTIONS

Articles and photographs suitable for publication in "The Indian Concrete Journal" are always welcome and those that are accepted, will be paid for.

CONCRETE ARCH QUANTITIES BY GRAPHICS

By T. W. OLIVER, Associate Bridge Engineer, Kansas State Highway Commission, Topeka, Kan

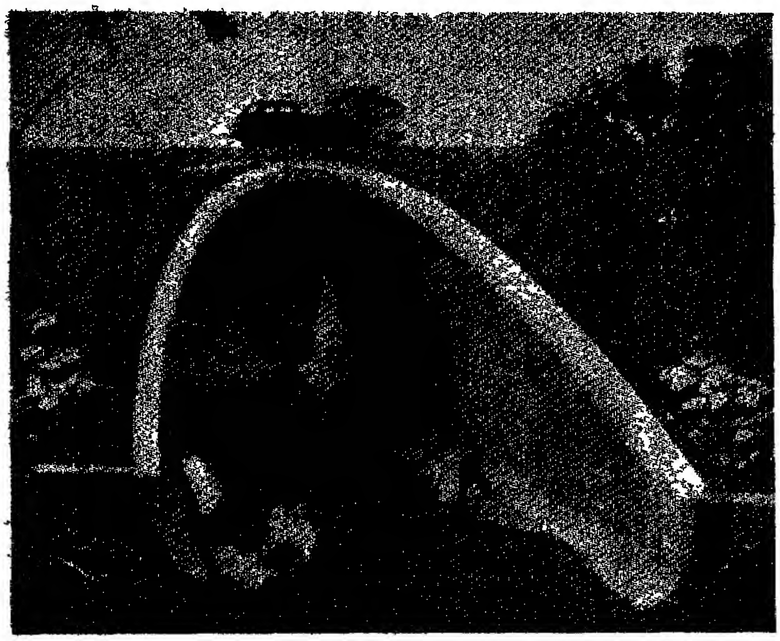


Fig 1. Concrete quantities in Kansas culverts are speedily and accurately calculated by a semi-graphical method

Contents in Brief—Computing the volume of concrete in sloping wings of arch culverts under Kansas highways is simplified by a combined graphical and analytical method Vertical sections are cut through the wings at frequent intervals These projected areas are "planimetered" and the volume of concrete computed by the average-end-area method Large-scale drawings speed up the work and give satisfactory results

FOR the past several years the Kansas Highway Commission has been calculating the volume of concrete in its arch culverts by a practical and satisfactory semi-graphical procedure Although not claimed to be original in its inception, the procedure herein outlined illustrates a simple yet expeditious method of accurately calculating the volume of concrete in the sloping end sections, or wings, of arch culverts

The shape of these sloping wings together with the superimposed concrete collars, or wing parapets, are such as to make strict mathematical calculation of their volumes impractical Consequently, the end-area method is employed with areas being obtained by planimetering cross-sections cut through the wing perpendicular to the barrel axis (see sections 4, 18 and 26 of Fig 3.)

Large-Scale Drawings

An accurately drawn, fairly large-scale and elevation of the culvert barrel and collar is needed, and a scale drawing of ½ in equals 1 ft usually will be satisfactory Cross sections are projected upon this elevation at 1-ft intervals near the high end and at not more than 4-ft intervals along the wing slope The following step-by-step graphical operations are required to project the necessary end-areas, ready for measuring with a planimeter (All references are to Fig 3)

1 Draw a half-section of the arch barrel (*a*) from the plan dimensions of the culvert and strike off 1-ft intervals along the vertical axis from 0 to 13 67 The top lines of the collar, 0-13 67 and 0-13 are projected later

2 Sketch the side elevation of the sloping wing (*b*) except for line 0 75-27 33 (intersection of back face of collar and barrel extrados) The solid line 0-27 33 represents the top face of wing collar and base line for collar projection The dotted line 0–26 is the intersection between the inside face of collar and barrel intrados Both of these lines are on the 1 on 2 slope of the culvert wing, and the dotted line 0–26 is the distance *d* vertically below line 0-27 33.

3 Lay out a half-plan of the culvert wing as shown in (*c*), except for the wing collar

4 Project the inside collar line, shown in (*c*) by intersection of verticals erected from points chosen in (*b*) and the projections of corresponding points from (*a*) which are rotated through the 45-deg line on to the plan view of the culvert wing

5 Construct the inside top line, 0-13, of collar in (*a*) by intersection of horizontal

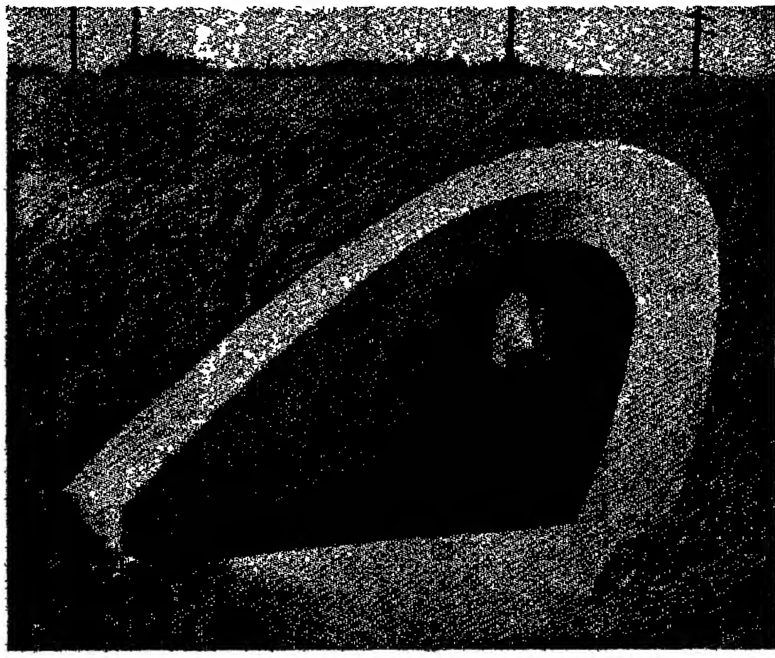


Fig. 2. Type of non-reinforced concrete arch culvert used under Kansas highways.

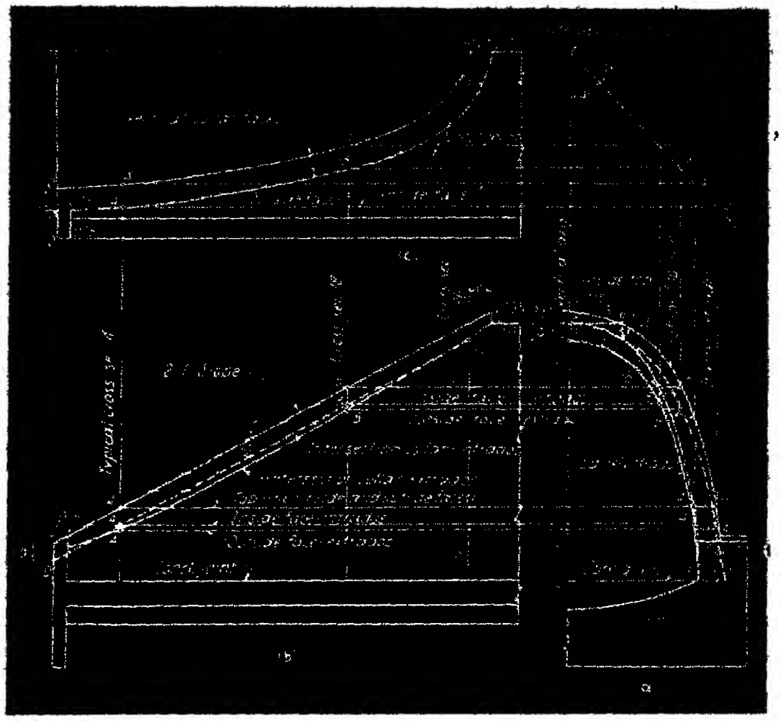


Fig. 3 Vertical sections are struck through the sloping culvert wings and projected onto an end elevation (a) for measurement by a planimeter in calculating the volume of concrete. Large-scale drawings of the side elevation (b) and plan view (c) of the wing simplify the mechanical construction and insure the accuracy of calculations

lines drawn from points selected on (b) and verticals erected from corresponding points along the barrel intrados The inside face of the collar is vertical so points on both the top and bottom inside lines of the collar will fall on line 0-26 as shown in (c).

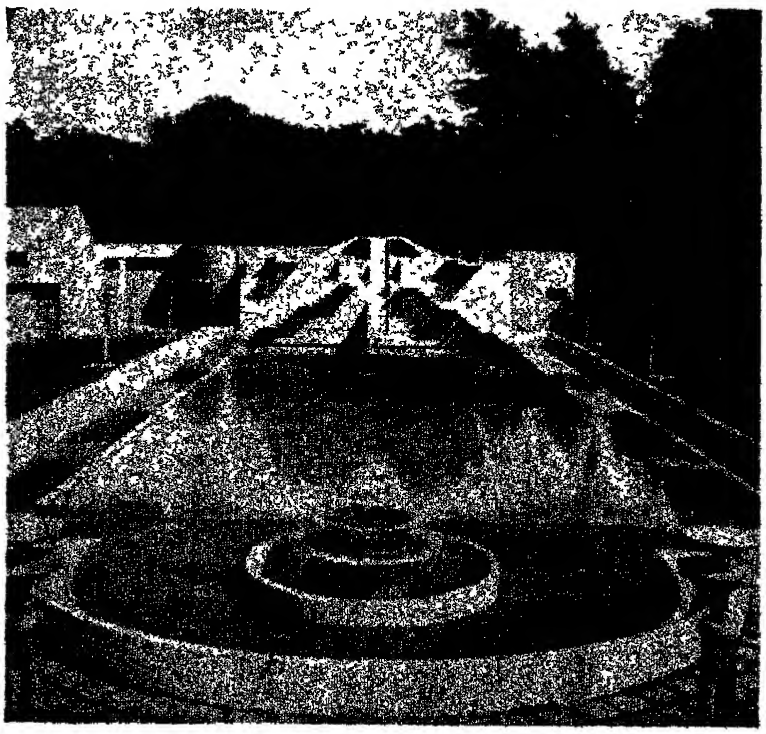
6 Plot the outside line 0-27 33 of the collar shown in (c) by using a compass set to a radius of dimension C and striking a series of arcs with the pivotal point of the compass placed at points along line 0-26. Short tangents to these arcs will form the desired outside line of the collar

7. Construct the outside top line of the collar in (a), designated 0-75-13-67, by the intersection of horizontal lines drawn from points selected in (b) and projections of corresponding points in (c), deflected through the 45-deg. line

8 From points along the outside top-line, 0 75-13.67, of the wing collar in (a), drop verticals to intersect the barrel extrados, shown as a dotted line From these points project horizontal lines to intersect corresponding verticals in (b) Through these intersections, draw the intersection line of the barrel extrados and the outside face of the collar in (b)

Typical cross-sections through the sloping wing and collar at points 4, 18 and 26 are shown projected on to the half-end elevation in Fig 3a The area to be measured at each of these points, indicated by dotted shading, is bounded by the rectangle cut through the collar and the intrados and extrados lines of the barrel, extending in each case down to the springing line at S-S

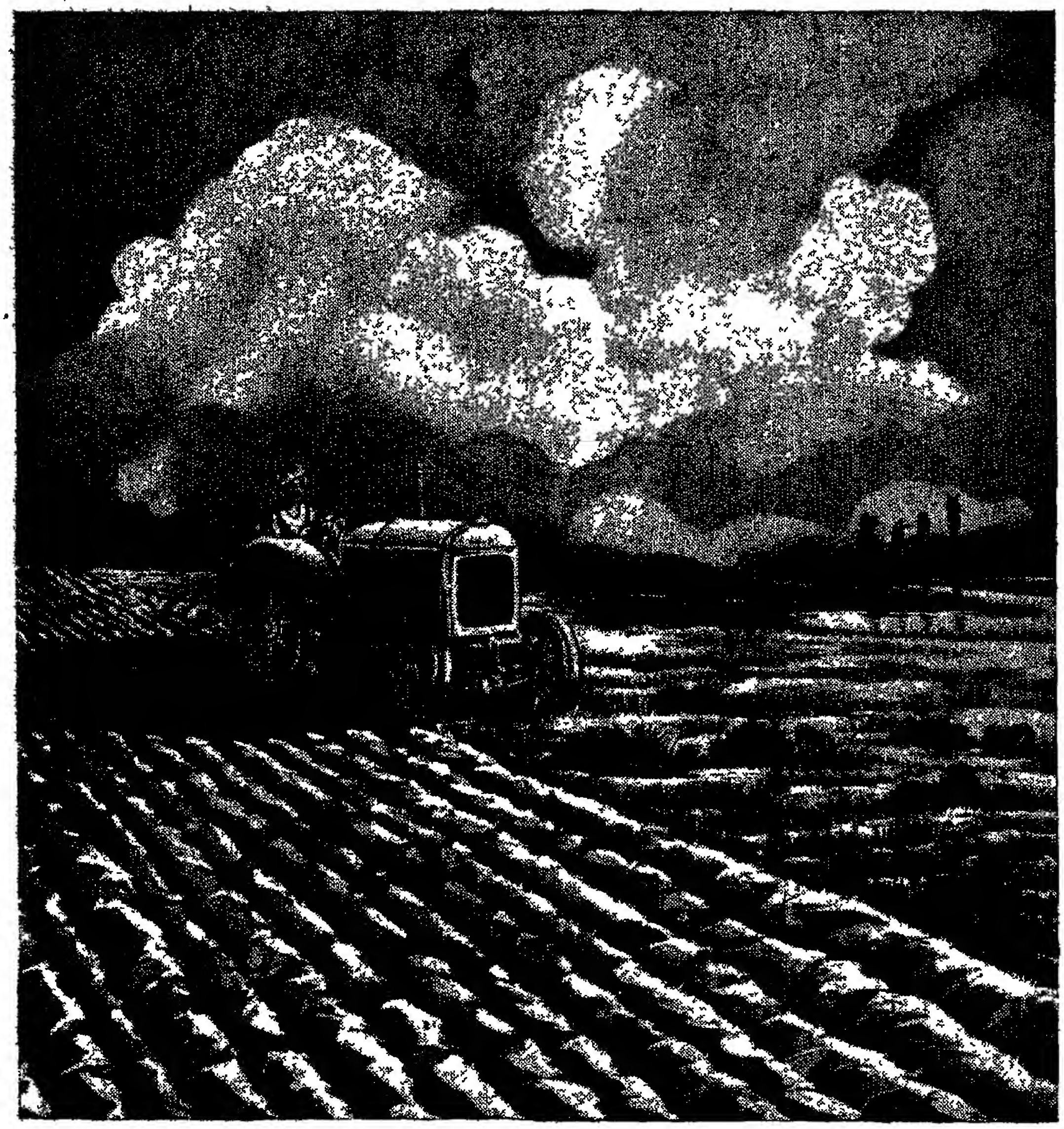
As a check on the accuracy of the large-scale drawings and the planimetered areas, the cross-sectional area of a section through the barrel should be computed for comparison with the area obtained by measuring with it a planimeter — (*With acknowledgments to "Engineering News-Record"*)



NEW R. C. SWIMMING POOL & SPORTS PAVILION

Kamla Retreat, Cawnpore.

On the centre spread of our June 1943 issue we published an illustrated article on the above. We are now reproducing another photograph taken when the "waves" of the pool were on.



Cawnpore Area (Contd.)

JAHANAGANJ ROAD
JAIS
JAKHANIA
JALALPUR
JANGHAI JN.
JANGIGANJ
JARWAL ROAD
JASWANTNAGAR
JAUNPUR
JEONATHPUR
JHANSI
JHUSI
KABRAI
KACHHLA GHAT
KACHHWA ROAD
KADIPUR
KAIMGANJ
KALPI
KAMALGANJ
KAMALPUR
KANAUJ
KANCHAUSI
KARARI
KARENGI
KARWI
KASGANJ
KASHI
KATHGODAM
KATHKUIYAN
KATKA
KAWAPUR
KHORIPUR
KERAKAT
KHADA
KHAGA
KHALILABAD
KHATEMA
KHETA SARAI
KHORASAN ROAD
KICHHA
KIDIHDAPUR
KOENDAUR
KONRH ROAD
KOPAGANJ
KUNCH
KUNRAGHAT
KUSMHI
LACHHMIPUR
LAKHIMPUR KHERI
LAKSHMIGANJ
LALGANJ
LALITPUR
LAR ROAD
LUCKNOW
MADHOGANJ
MADHOSINGH
MAHMUDABAD
MAHOBA
MAHOLI
MAHPUR
MAINPURI
MAKHANDPUR
MALIHABAD
MALIPUR
MALLAWAN
MANAURI
MANDAH ROAD
MANKAPUR
MANPUR NAGARIA
MAREHRA
MARIAHU
MASKANWA
MAU AIMA
MAU NATH BHANJAN
MAURANIPUR
MEJA ROAD
MIRANPUR KATRA
MIRZAPUR
MISRIKH TIRATH
MOGHAL SARAI
MOTH
MUHAMMADABAD GOHNA
MUNDERWA
MUSAFIRKHANA
NAGARIA SADAT
NAIPALGUNJ ROAD
NANDGUNJ
NANPARA
NAUTANWA
NAWABGUNG GONDA
NIBKARORI
NOWGARH
ORAI
ORCHHA
PACHPERWA
PADRAUNA
PARIAWAN
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SAIYEDRAJA
SAKALDIHA
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SANDILA
SARAIMIR
SARDARNAGAR
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SHOHRATGARH
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SIKANDARPUR
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TAHSIL FATEHPUR
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TAMKOHI ROAD
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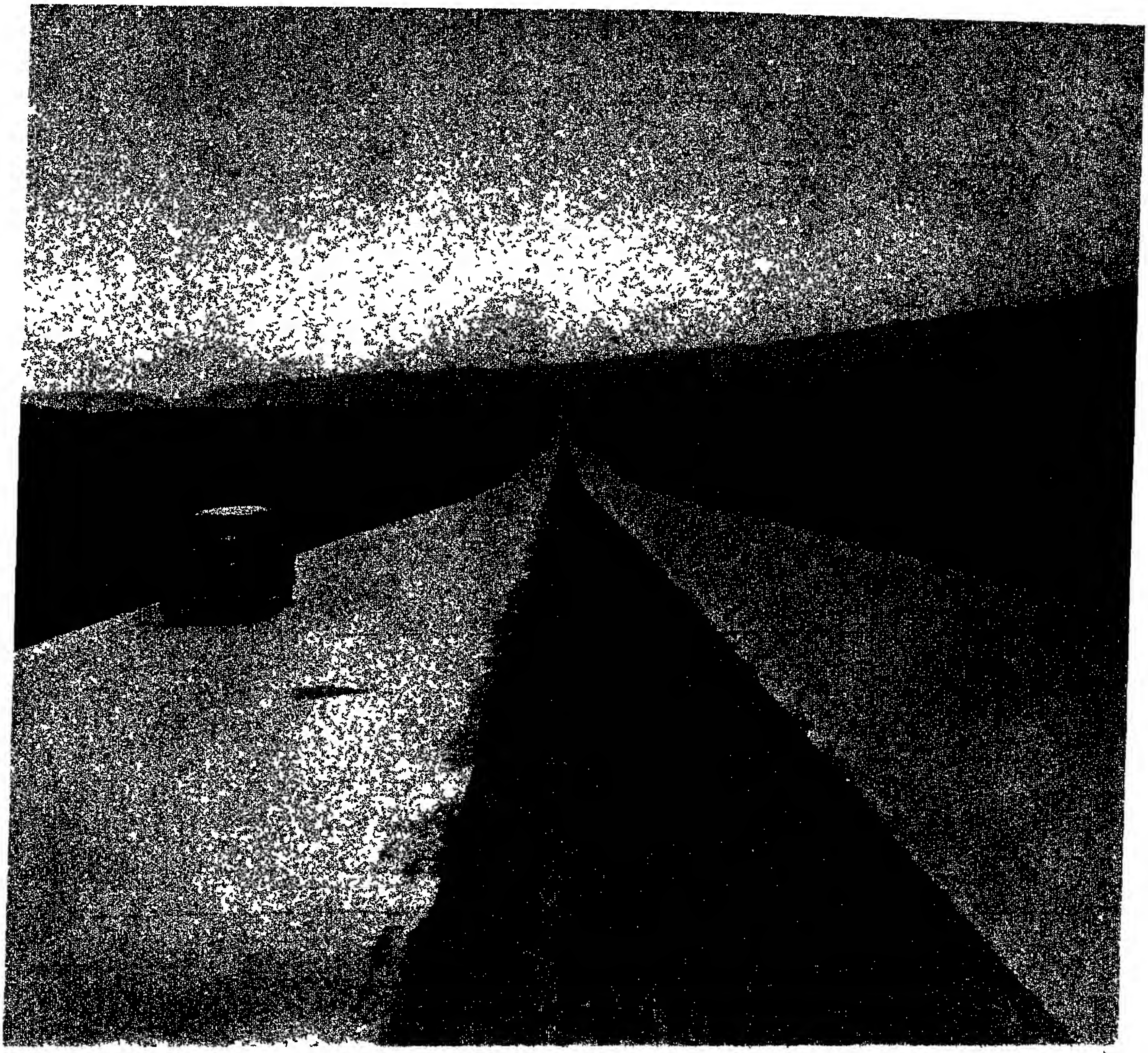

Photo Fenno Jacobs, Three Lions, New York

12 MILE STRAIGHT-A-WAY, THE LONGEST STRAIGHT STRETCH OF ROADWAY ON THE NEW SUPER-HIGHWAY, U.S.A.

CEMENT CONCRETE IS THE BASIS OF ALL MODERN CONSTRUCTIONS

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INDIAN CONCRETE JOURNAL

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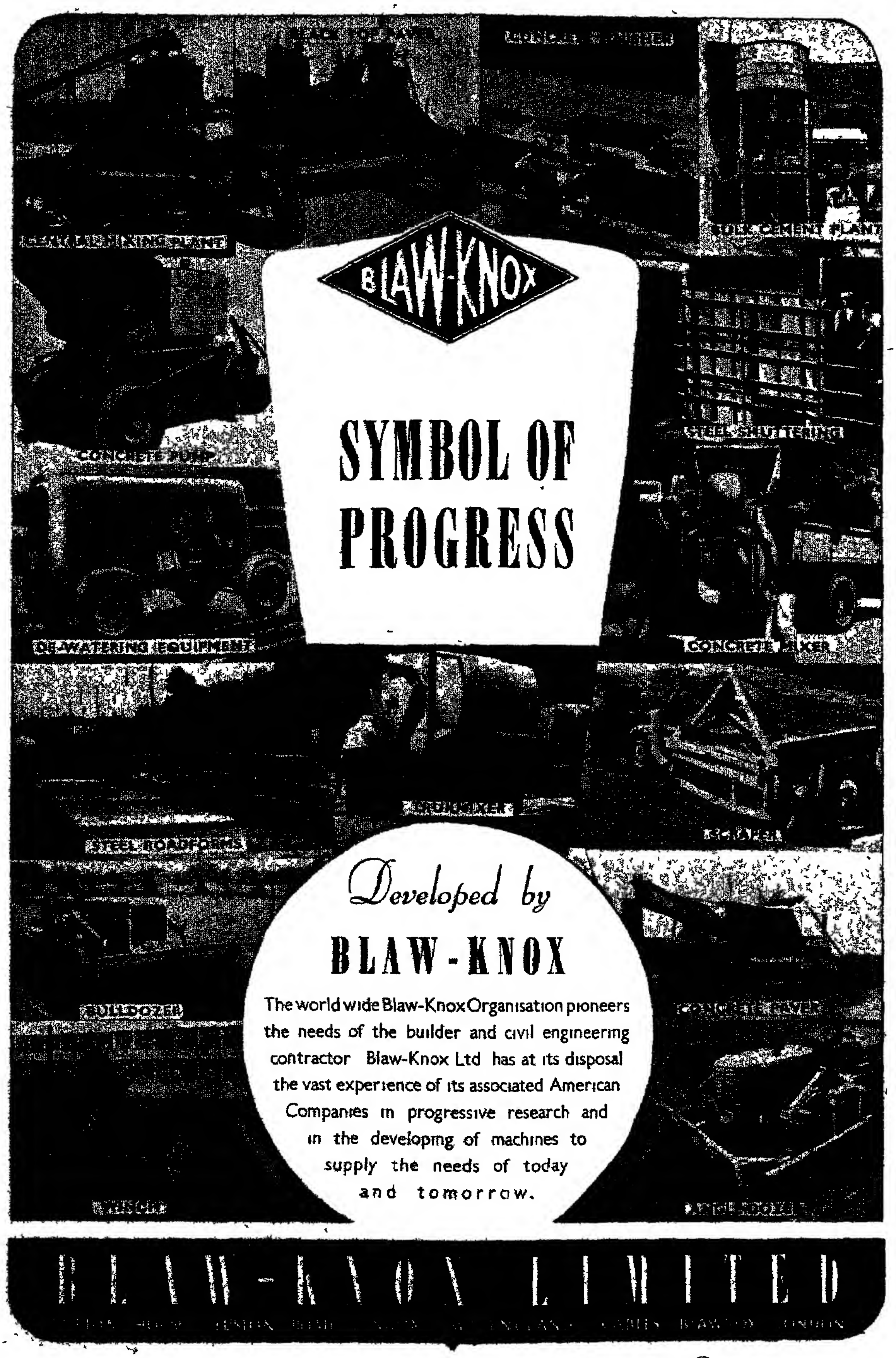
ENTRANCE TO THE NATIONAL STADIUM IN SANTIAGO, CHILE

(See Back Cover)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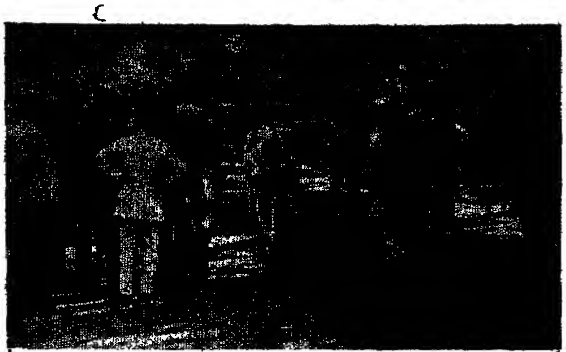

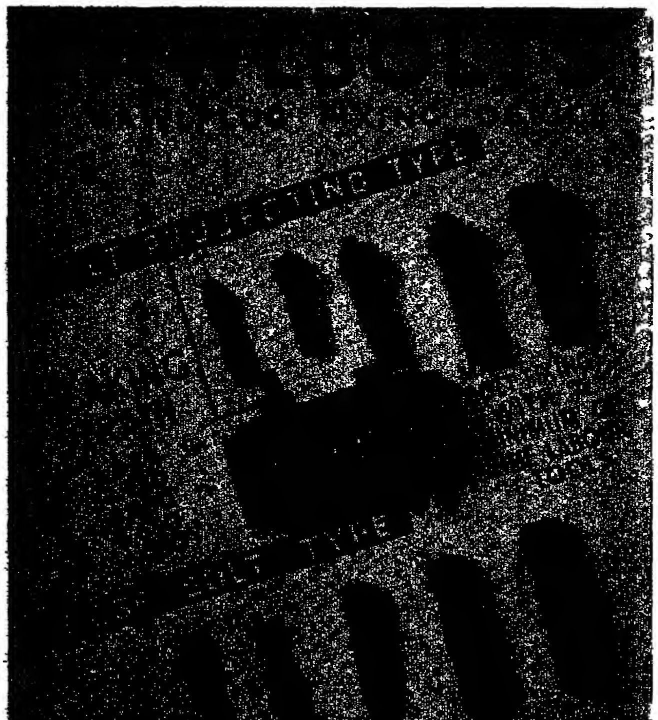

March 15th, 1945

The INDIAN CONCRETE JOURNAL

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ASST. TECHNICAL EDITOR :—
H. S. Batliwala, B.E., M.I.E. (India), M. I. Struct. E., M.I.H.E. (London).

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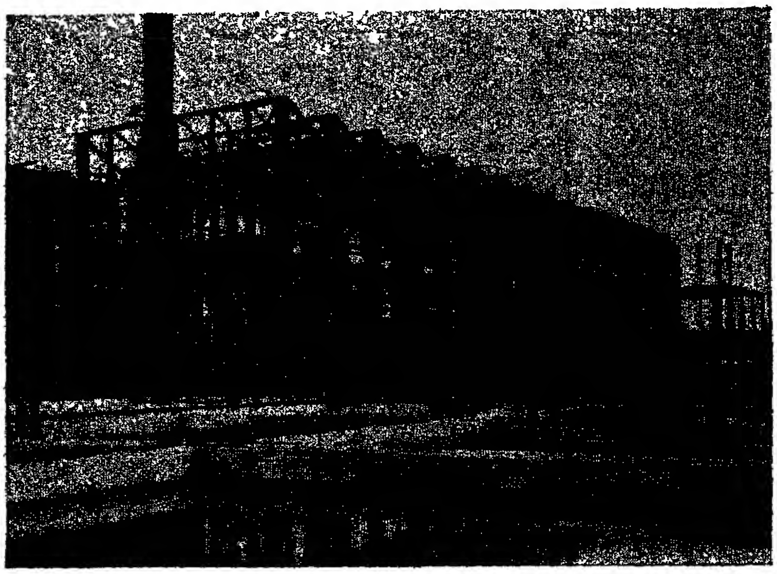

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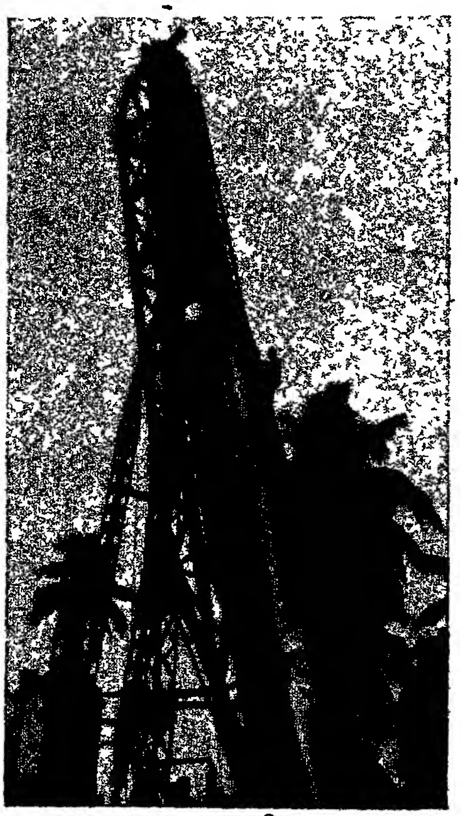

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NEWS & NOTES

ARCHITECTURE IN INDIA

The following is the radio talk given by Mr L M Chitale, F.R.I.B.A., A.M.T.P.I., at the All India Radio, Madras, on the 17th February 1945 at 9-45 p.m.

RECENT excavations at Mohenjo-daro and Harappa have disclosed evidences of scientific town planning in finely built cities of 5000 years ago Broad streets, varied requirements and types of buildings, high standard of workmanship, elaborate systems of water supply and drainage, were surprisingly advanced for the age. Wood, brick, stone, copper and bronze have been used to very good advantage.

Indian art aims at interpreting the Infinite and the Absolute It tries to express the Formless into forms and the Infinite into the finite. Indian architecture has evolved and maintained a distinctive individuality of its own in spite of the progressive changes introduced by different schools of thought The teachings of the Upanishads can be traced not only in the sculptures of Amaravati, Sanhi and Borobudur and the frescoes of Ajanta but also in the conceptions of Indian architecture through the ages Its religious and mythological background has thus helped to preserve its unique features but the survival is, in the main, due to its intrinsic scientific merits.

The great scientific treatise, Vastu-Vidya shows that Indian architecture reached its peak of perfection long before the Christian era This treatise deals scientifically with all aspects of planning, construction, materials, site selection, weight, pressure and resistance, physical security and strength. There is instructional scope and guidance in the work even for the architect of today

It is unfortunate that most of the research work done so far regarding ancient Indian architecture has been conducted on lines that miss what I might call the soul of the subject A thorough knowledge of the ancient Indian languages, mythology and religion would be the first essential for any correct grasp of the subject. A good deal of expert research work conducted on right lines is needed before a correct perspective can be obtained to interpret the evidences available to us in the monuments and museums in India and abroad.

Forms, styles and expressions appear to have been fully developed and understood in old Indian architecture. The Audience Hall of the Pandava princes with its crystal floor and beautiful gardens is said to have been the colour of a newborn cloud of white. The white colour against the sapphire blue background of a clear, unclouded Indian sky is typical of most of the Kailas exhibits The use of stones for rock-cut shrines, thrones, umbrellas, pillars, rails, gateways and arches was a feature of the glorious architectural activity of the Asoka period Pillars and flag-staffs in various sizes, shapes and styles in iron, stone and wood are evidences of the period when architectural decorations of cities became an integral part of Hindu temple architecture. Jain conceptions and creations were responsible for Plinths and Friezes, Chajjas, Shikaras and Domes that are master-pieces of human ingenuity and patience. Jain temples owe much of their attractiveness to their environment by their picturesquely grouping on mountain tops.

The fifth, sixth and seventh centuries A D covered the most brilliant period of Renaissance in Hindu arts and literature European architecture of the medieval period owes much to this Renaissance The caves of Elephanta, the Kailas temple and the Ellora caves may have been finished during this period In later years, building activities in north India were influenced by Moghul and Rajput schools when temples, palaces, enriched lakes, bathing ghats and wells were built In south India, however, Indian architecture has remained predominantly Hindu and the influence of Vasty-Vidya can be seen in the ingenuity of artistic expressions in 1000 pillar Mandapas, gopurams and temples, the master-pieces of Indian craftsmanship

The inherent strength of Hindu culture and tradition resisted the attempted domination of outside influences on Indian architecture during the medieval period when the country was a prey to several foreign invasions Thus, Moghul art in building accepted the basic individualism of Hindu architecture and came to stay whereas the Greeks, Portuguese, Dutch and French had very little to contribute of their own The little influence that could be noticed in that period indicates insignificance rather than domination Until far into the nineteenth century, Indian architecture remained predominantly Indian

During the Viceroyalty of Lord Dalhousie, the first signs of foreign domination in architecture are in evidence Planning of buildings at the Public Works Department was first in the charge of military engineers and later they were replaced by Design Specialists who were subsequently called Consulting Architects Standard types of designs became and still are the monopoly of the P.W D The buildings of this period in Calcutta, Bombay and other cities strike a very discordant note indeed against the background of an ancient culture.

Subsequent developments in Indian architecture show a conflict for a clear policy. The Romans superimposed their traditional styles on all the countries they conquered, The English had no traditional style of their own to plant on the Indian soil and so Greek and Roman architecture was introduced Due to inadequate control in planning and supervision, secondhand Gothic and third-rate Classic styles sprang up in India, with very unhappy results Any style or expression was used for any building whether it was secular or religious. The reaction to this blunder was a later attempt to invent and create a typical Anglo-Indian style based on Indo-Saracenic patterns Something might have come out of this attempt, if the greatness of Indian traditions had been understood and the co-operation of the Indian master builders of the time secured

The third school of thought desired the revival of traditional Indian architecture and its adoption to modern conceptions and methods of construction at New Delhi As a result of great efforts and discussions in India and in England in this connection, the European architectural style was finally preferred though in execution, a mixture of artistic expressions of East and West unconsciously crept in Here again the mixture is the result of an imperfect grasp of the traditions underlying a five thousand year old culture Co-operation between the architects of the West and those of this country could have secured far better results in the sum total of achievements

The Great War of 1914 revolutionised human outlook and in the post-War rebuilding in Europe and U S A traditions and symbolism gave place to modernism and stressed the utility aspect of human endeavour The ancient buildings in Greece and Rome are now but relics of cultures that are forgotten in the present-day rush of industrialisation and modernism in Europe Over-population and crowding have created problems of sanitation and town-planning that can take no account of past traditions or glories The present war will intensify these problems

By constant propaganda and environment, the machine age will force its standards of modernism on our minds The forces at work in the modern world are more subtle and more powerful than the influences that the foreign invasions of the past brought to bear on Indian culture There is every danger of Indian architecture, after retaining its unique individuality for over five thousand years, now being merged and absorbed into the present craze for modernism This is the pitfall that we must studiously avoid if we are to preserve our traditional greatness

At the same time, India has to take her place in the present day world of industrialism and face the problems that industrialism brings in its wake It is therefore necessary for us to create standards of our own to suit modern conditions so that we can at the same time retain the legacies of our own

traditional Indian architecture This requires a definite policy and careful and studied planning for the future, coupled with intensive research into our past history

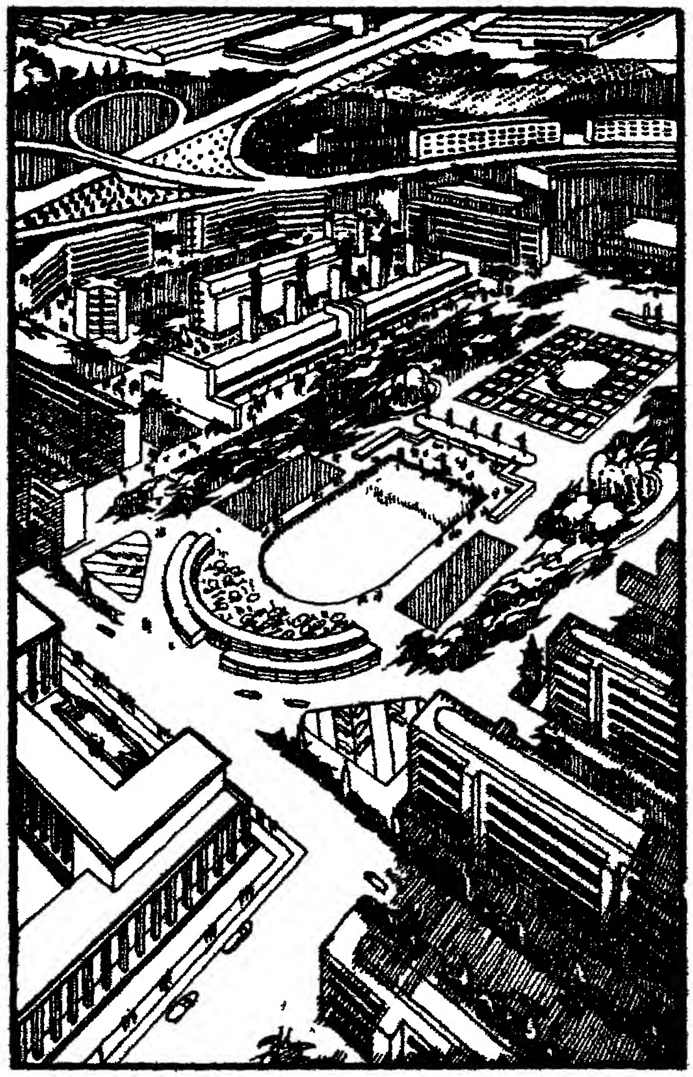
An important aspect of the future architecture of India is the planning and re-planning of cities and their buildings, roads, bridges, water supply, drainage, sanitation and other services, all of which are necessitated by modern conditions Aesthetics will have a large bearing on adequate setting, appropriateness and functionalism as demanded by conditions in urban and rural areas. Each country in the West has tried to solve its problems in its own way There is a great deal to learn from their experience and achievements, with a view to applying them to Indian conditions economically and efficiently A vast continent like India presents different local conditions and atmospheres each of which constitutes an individual problem of its own In solving these, efforts must be made to bring out the best of Nature and Art in harmony with the Indian life and its individuality

A first essential would be the training of Indian architects who can live in the spirit of traditional Indian architecture while being at the same time in constant touch with the progress of the science in other parts of the world. Lord Curzon, with his enthusiasm for Indian architecture, initiated the policy that resulted in the creation of the School of Architecture in Bombay, but unfortunately this institution does not give full importance to our hereditary science More schools, with better co-ordination between modern tendencies and our age-worn and tried assets should be started. Institutions of architects, engineers and contractors must be established to contribute to the sum total of achievements in planning of space and building.

The building industry must be established and building research Boards must be set up to draw specifications, establish standards and tests of materials and their equalities as demanded by varied Indian conditions. Municipal Licences should restrict and regulate the work of architects so that the ideals of form and expression are not sacrificed to the greed of capitalistic investments. The curse of mass production methods has often created monstrocities in cement in which functionalism and appropriateness have been sacrificed to the craze of modernism.

New requirements seek new methods and new materials. Cement has opened up immense possibilities for the future. Its use for evolving styles and expressions within our ancient monuments needs careful research. Urban, rural, climatic and economic conditions have a large bearing on the use of cement in India. These aspects require frequent investigations on the basis of experience

The global war has brought about changes all over the world in outlook, taste and conveniences Science has brought the world regions closer together than they have ever been In result new materials and forms would be born. While transplanting and transforming old into new, the individuality of Indian architecture must be maintained to suit Indian conditions and artistic environments Our aim must be to have varied patterns rather than a monotonous one to maintain the individuality of the races for pleasure and delight, the structure of the reconstructed world of tomorrow.



THE PLANNED CITY OF THE FUTURE

THE city of the future, if carried out anything like the illustration by the Brightside Foundry and Engineering Co of Sheffield, will at least have plenty of light and fresh air inside the buildings, as well as outside, but, also, if we are to judge from this design, recreation instead of hard work will be the centre of our activities, since here it would seem to be the hub round which all the principal buildings cluster and to which all the main streets converge. In this case the recreation centre does not merely mean a public park with trees, but includes a fine bathing pool, dressing-rooms and restaurants, a stadium and tennis courts, bowling greens and football field The shopping centre seems to overlook these grounds, and the residential and office buildings radiate from, or encircle these. It is hoped, however, that they will never be dispensed with in the industrial area at the top city and suburban streets Note the industrial area at the top left, and the two-level exit from the city —(" *Building and Engineering* ")

SUSPENDED FORMS USED IN CONSTRUCTING CIRCULAR RESERVOIR AT FOOD PLANT

MODERN design and economy of construction characterize use of reinforced concrete at the La Choy Food Products plant, at Archbold, Ohio division of the Beatrice Creamery of Chicago The project includes the main factory with 60,000 sq ft of concrete floor, a water-works, and sewage-disposal system, the latter large enough to treat all the sewage of the Village of Archbold, as well as processing wastes and sewage of the plant itself Outstanding from a construction viewpoint is the concrete shell roof of the 750,000-gal. reservoir of reinforced concrete, 90 ft. in diameter and 16 ft. deep, supported by eight 45-ft concrete beams built by use of suspended forms

General view of project nearing completion. Note the cableway for delivery of concrete.

The reservoir is part of a 2,200-gpm water distribution system, which, with the 1-mgd. treatment plant fully equipped, cost less than $100 thousand

Credit for engineering design, layout and construction supervision goes to F E Nichols, project engineer The sewage treatment plant and water system were built in the summer of 1943 with an average construction crew of 23 men, including mechanics and labourers, one $\frac{1}{2}$-yd crane, two 2 bag concrete mixers, a bulldozer and miscellaneous small equipment

Main supports of the reservoir roof are radial beams which span from the 12-in circular monolithic wall to the central 6 ft by 6 ft concrete column They are 12 in wide and 16 ft. deep, set in beam pockets at their outer ends, bear directly on top of the centre column, and provide beam pockets in themselves to receive the lateral concrete tiebeams, 8 in wide, 12 in deep and 19 ft long The concrete shell roof is $3\frac{1}{2}$ in thick and has a sphere radius of 125 ft

The 12-in circular exterior wall rests on a footing 7 ft. wide and 3 ft deep and is braced on the outer circumference with 16 battered pilasters 2 ft wide and 1 ft thick at the top and thickening out at the bottom to 3 ft

The wall forms for the 90 ft diameter reservoir were first used to place the 2 filters As additional 10 ft was then added to them to increase the height to 16 ft These circular forms were constructed with horizontal ribs sawed from 8-in lumber, the walers were set vertically, and snap ties were used on 2-ft centres both ways

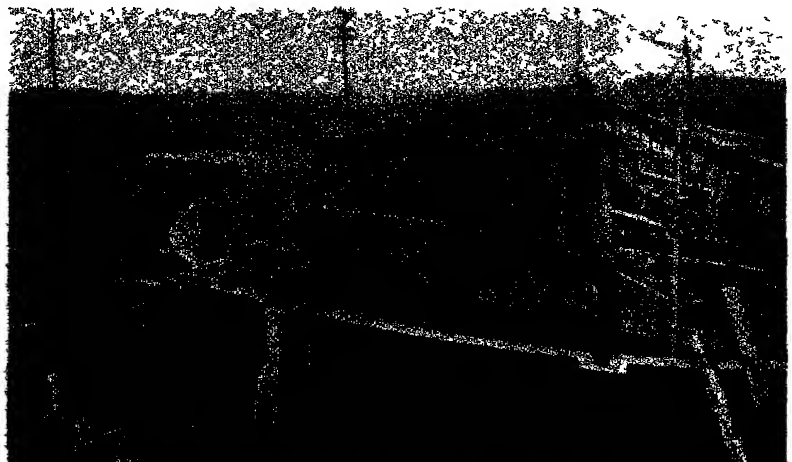
On top of the wall forms an 8-in track was built around the entire inside circumference resting on the vertical walers to take the casters on the outer end of a steel chute built of salvaged pipe from a local planning mill and trussed with some of the used sucker rods This chute was 50 ft long Its upper end was fitted with a bolster plate resting on a timber stand 4 ft above the top of the central pier which is 9 ft higher than the outside wall This let the entire chute rotate the full circumference of the wall

Serving this rotating chute was an improvised concrete bucket which travelled on an overhead cable-way similar to the high rigging used for logging The bucket rested in a pit under the 2-bag mixer located under the chutes of the batcher The cableway was operated by a steam winch raising the concrete bucket 45 ft in the air to the tight cable, locking it to a trolley similar to the mechanism used in forking hay into a barn The bucket was then coasted out to the concrete chute, where it was dumped This placement procedure was used to pour all beams, roof shell, and walls

By the time the wall was poured, the radial beam forms were built and bolted to a 12 × 12-in rock elm timber 50 ft long rented from A J Fields, rigging contractors of Wauseon, Ohio. These timber were selected from well seasoned stock In other words, they had been well stressed from constant use for several years so there was very little bending encountered This timber was supported on the central column of the reservoir by an A-frame built of laminated 2×8's, and on the outer wall by another A frame Forms were set with the central section raised $\frac{1}{2}$ in higher than final level to overcome the total sag that was encountered in the timber The sag was determined by setting the entire assembly in place before the forms were bolted to the timber

The form was suspended from the timber by 2 × 4 hangers on 2-ft centres, and the bottom form panels were made removable by inserting $\frac{3}{4}$-in bolts under the panels on every other hanger

The entire beam form assembly weighed about 1,000 lb To change it to a new position, the bottom panels were removed and a chain fall was rigged from the overhead cable in the centre of the reservoir, a crane was brought into position at the outer end, and the entire form assembly was raised off the finished beam and pivoted to the new position by the crane



Radial beam forms were hung from a 12 x 12-in. seasoned rock elm timber spanning from centre column to circumferential wall These forms were suspended by 2 x 4-in hangers bolted to the timber on 2-ft. centres.

A saving both of lumber and labour was

effected in building the concrete radial beams over the reservoir with suspended forms instead of the conventional shoring method It was estimated by Mr Nichols that the shoring method of supporting the forms would have taken an additional 3,000 bd-ft. of dimension lumber, and would have required an additional 192 carpenter manhours Six hours were taken to move to each new position as against 3 days for the shoring method —(*With acknowledgments to "Concrete"*)

Wall forms in place. Note end of rotating concrete chute in upper left of the picture.

NOTES ON RIGID PAVEMENT DESIGN

IN a paper written by Rudolph Glossop and Hugh Q Golder, and delivered recently before the road engineering division of the Institution of Civil Engineers, Great Britain, some interesting design data were developed Principal observations of these men, as reported in "Highway Research Abstracts," follow

"The main purpose of the paper is to present a method of design of flexible pavements which is simple and practical, and which is based on the measured strength of the subgrade and the magnitude of the loads applied to it

"It is usual to describe pavements as (1) rigid, or (2) flexible, but this classification is unsatisfactory A reinforced-concrete slab resists bending by deflecting and so develops a resisting moment, thus a 4-in. reinforced-concrete slab, although classed as a rigid pavement, may, in fact, be far more flexible than 18 in of stabilized soil, which would be classed as a flexible pavement

"If this classification is adopted rigid pavements should be defined as those which will resist bending and flexible pavements as those which have negligible tensile strength and cannot resist a bending moment Thus rigid pavements include those of reinforced concrete, metal, or timber, and flexible pavements those of hardcore, water-bound macadam, stabilized soil, or sand asphalt It would, in fact, be preferable to divide pavements into the two classes 'tensile' and 'non-tensile', flexible pavements and pavements of unreinforced concrete falling into the second class

Sound Theoretical Basis

"The authors state that the method has a sound theoretical basis, is essentially practical, and is simple enough to be used by anyone more or less unacquainted with the theory on which it is based Moreover it is extremely versatile and the thickness of pavement can, if necessary, be varied continuously to suit the subgrade, thus resulting in an economical section A further important point is that it can be used when the shear strength of the subgrade varies with depth; this is a distinct advantage over the use of a formula which can be applied only to a material of constant shear strength The bases of the proposed method are:

"(1) To make a soil survey of the site, shear strength of soil samples being determined by the unconfined compression test.

"(2) To ascertain the tyre contact-areas and the load per tyre of the vehicles which the pavement will be required to carry.

"(3) To calculate the thickness of pavement required to reduce the stress in the soil below the safe value determined by the soil survey; the result of this calculation is represented graphically so that the shear strength of the soil having been measured in the field, the required thickness of pavement can be read off at once.

"It should be noted that

"(1) This method of design is applicable to pavements of unreinforced concrete, stabilized soil, hardcore, etc, always provided that the shearing resistance of the base is sufficient to resist stresses imposed by the loading and that the other requirements of resistance to abrasion, impermeability, etc, are satisfied.

"In the case of concrete it is unnecessary that the full depth should be of a rich mix Where the required depth is large, hardcore, stabilized soil, or lean dry-mixed concrete may be used for the lower portion, provided that it is thoroughly compacted

"(2) The method is applicable to a subgrade of clay, but not to sand. Sands have a high frictional shearing resistance and if properly drained and compacted are unlikely to fail under normal conditions of pavement construction and loading.

"The first step in the calculation of the thickness of pavement required is to determine the stresses in the subgrade These will depend upon the loads applied to the pavement. For aerodrome and lorry traffic the area of contact of a tyre on a vehicle can be determined by measuring the major and minor axes of the ellipse of contact. The diameter of the circle of equivalent area can then be calculated, and the load supported by the tire can be divided by this area to give an assumed uniform pressure acting over an equivalent circle. This is accurate enough for all practical purposes. The elastic properties of the base and the subgrade are dissimilar, but if the assumption is made that they together form a homogeneous isotropic semi-infinite elastic solid—and such an assumption is generally considered permissible in dealing with soils—then the vertical pressures on a horizontal plane at any given depth can be calculated from Jurgenson's tabulated solution of Boussinesq's equation integrated for a circular loaded area

Required Thickness

"The vertical pressure on the subgrade depends upon the thickness of the pavement, and the required thickness of pavement is that which restricts the maximum pressure on the subgrade below a certain value which is a function of the shear strength of the subgrade Three possible limiting values to the pressure on the subgrade have been considered, and observations have been made on actual failures to determine which agreed with the facts

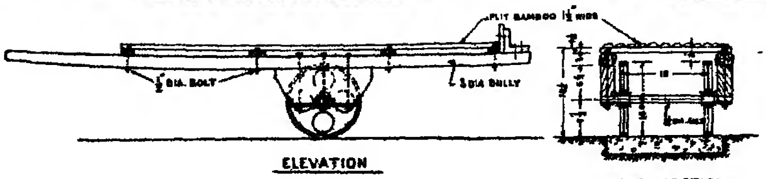
"(1) The first criterion is to keep the maximum pressure below pi times shear strength, since at this value (unit pressure equals $\pi \times s$) the plastic state is just reached in the material. This seems a rational criterion of design, for although a slightly thinner base may be stable, one whose thickness fulfils this condition is the least that is known to be stable

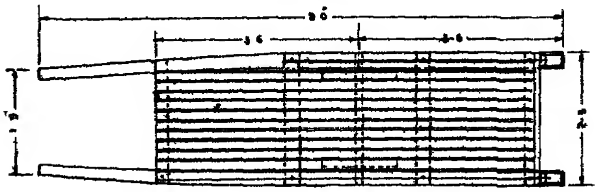
"(2) An alternative criterion of design is to calculate the pressure which will cause shear failure of the subgrade and then to use an adequate factor of safety on this value. Hencky gives the ultimate bearing capacity of a circular area as 5·64s (s = shear), and although tests have indicated a possible higher value (6·7s) it will be wise to take the lower value for design. For structures which are sensitive to settlement Terzaghi considers that a factor of safety of 2½ to 3 should be used, and since the present problem is a question of deformation rather than shear failure it will be wise to use the higher value. This factor of safety must be applied to the 'mean' pressure over the surface of the sub-grade."—(*With acknowledgments to "Concrete."*)

CONCRETE TRACK-WAYS FOR SINGLE-WHEEL BULLOCK CARTS, HAND-CARTS, CYCLES, ETC.

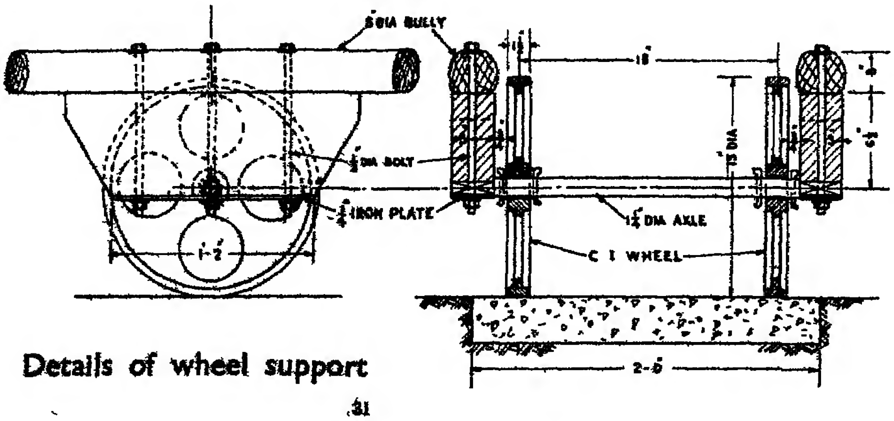
(Particulars overleaf.)

This line drawing is prepared from an actual photograph

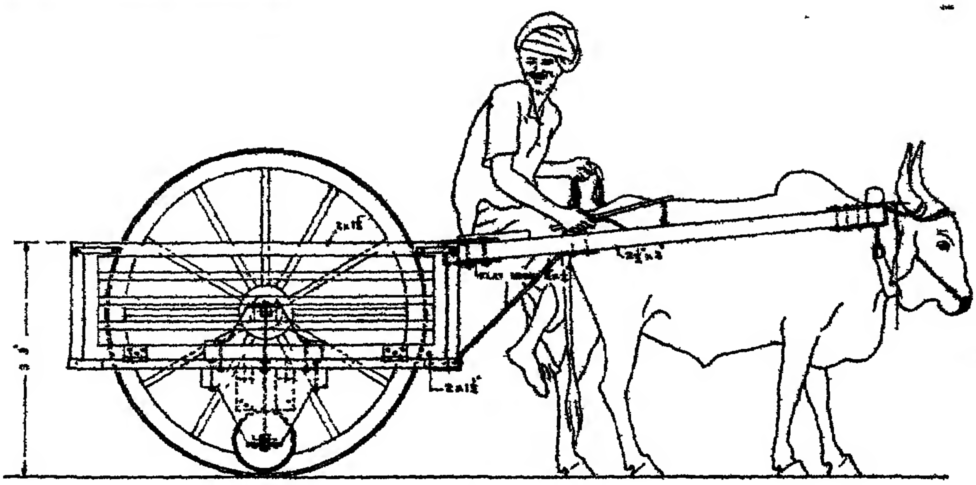


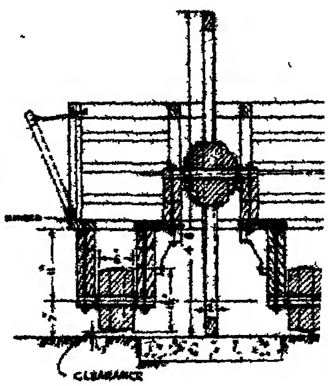


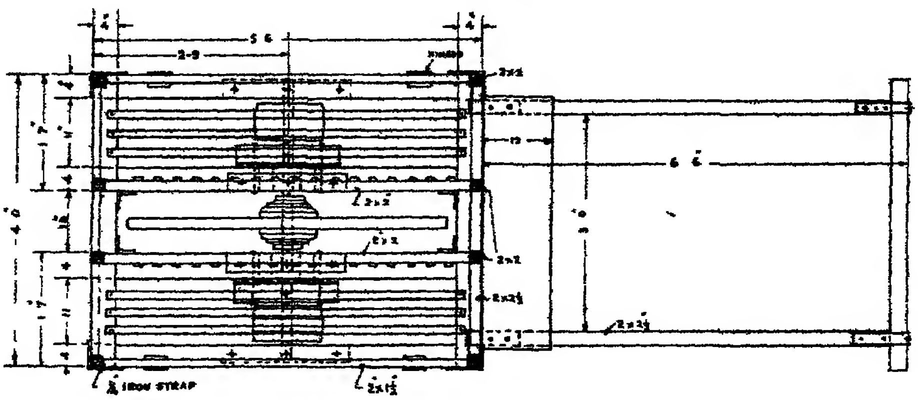
Hand-Cart for use on 2′-0″ Concrete Track-ways



Details of wheel support







CONCRETE TR
WHEEL BULLO

Details of single-wheel Bullock Cart

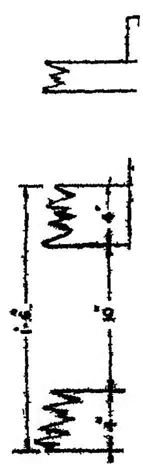
ON these pages are given details of the one wheel bullock cart and hand-cart which have in the short time elapsed since the demonstration at Virar (near Bombay) caused so much response from so many quarters

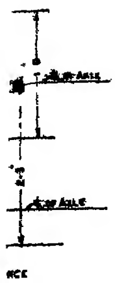
The keen interest awakened in all parts of India has led us to think that there must be a real demand for cycle tracks capable of taking single-wheel or narrow-gauge vehicles, cycles, motor-cycles, etc.

The single-wheel cart idea was taken from China where they are common and used mainly on 3 foot bunds between rice-fields

In China the motive power is human, a strap being passed over the man's shoulders while he pushes and balances the cart, the load being spread evenly round the central wheel. In this country, it is considered likely that the bullock will have to be employed; hence the necessity for the two stabilizing rollers, without which the cart would tip over sideways, but practically all the load will come on the central wheel and very little on the bullock or on the rollers One of these rollers at a time will bear lightly on the earth berm at the side of the concrete track

In China they use stone slabs laid along the tops of the berms but it is obvious that a concrete track would be better and if, as may be expected, the stone, sand and





labour are provided by the villagers the cost should be limited to the price of a small amount of cement. These track-ways will be invaluable for communication between village and village, and between village and road or railway, and due to the narrow width, all-weather crossings over nallahs and streams could be made at an absolute minimum cost. These track-ways will be available also in all states of the weather for pedestrians, pack animals, cycles, motor-cycles, narrow-gauge hand-carts, and one-wheel carts

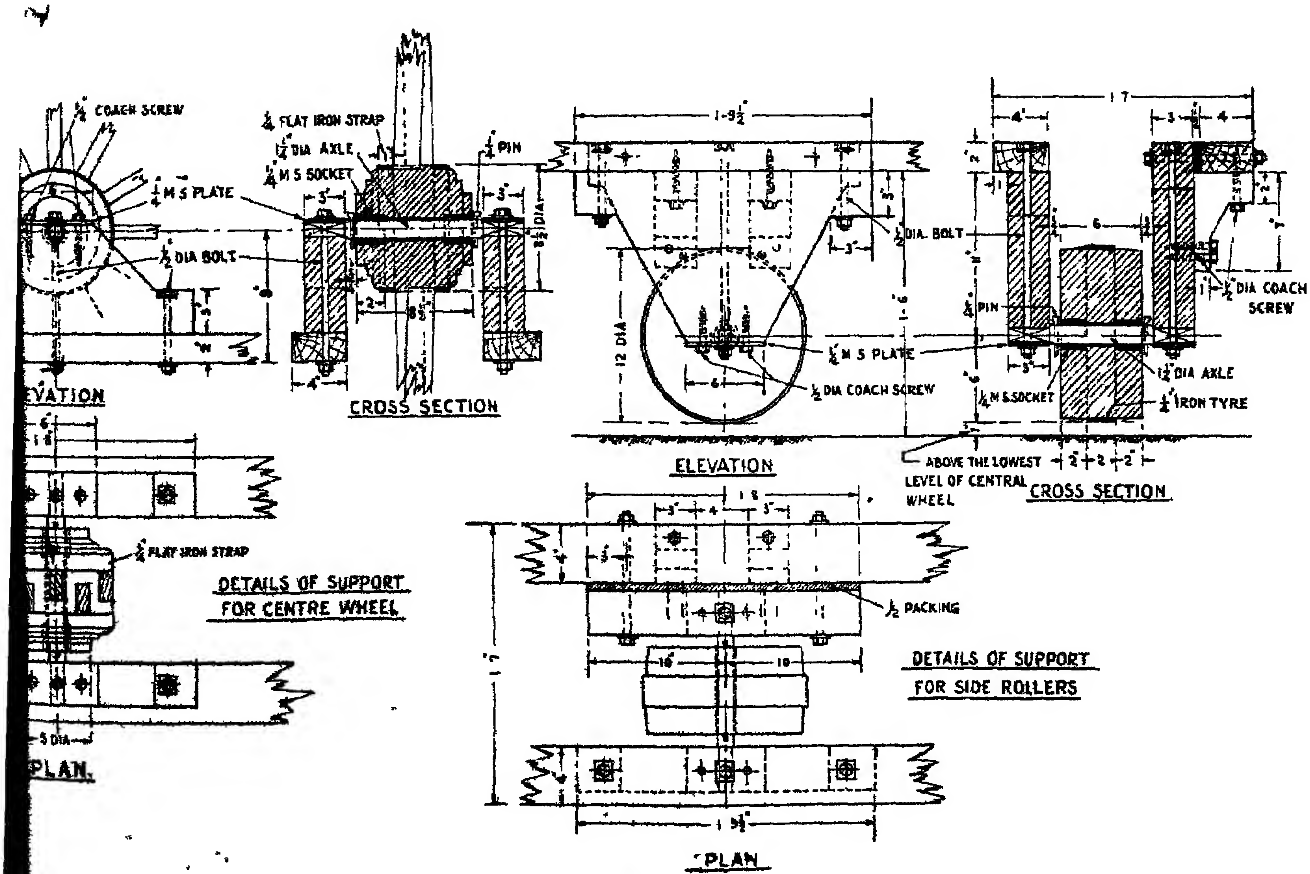
A further advantage of the single track is that it can, at a later date when circumstances demand and finances permit, become one of the two tracks forming the well known and well tried creteway.

It must be clearly understood that the one-wheel cart is not designed to displace the ordinary bullock cart, but only as a means of taking loads up to about 10 cwts across country where the ordinary cart cannot go

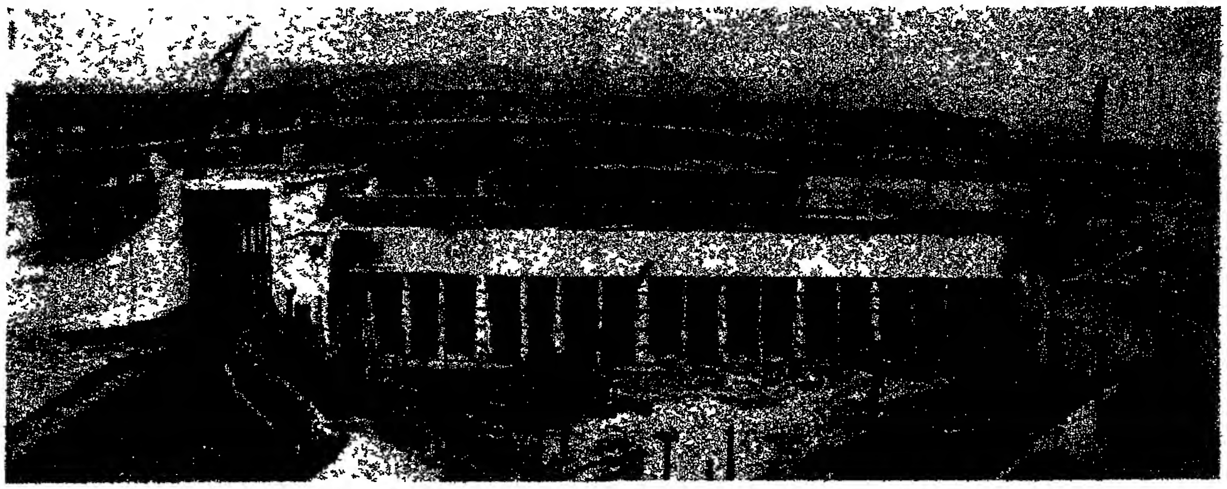
We hope that the particulars given, both of the hand-cart with its narrow-gauge and the single-wheel bullock cart with its stabilizing rollers, will be sufficiently clear to enable anyone to have these vehicles made by local wheelwrights or carpenters There are no patents or restrictions.

We are determined to further rural communications including nullah crossings All constructive suggestions in this connection will be welcome

-WAYS FOR USE BY SINGLE- :ARTS, HAND-CARTS, CYCLES, ETC.



GIANT PUMP STATION GIVES TWO-WAY FLOOD PROTECTION



2½ YEARS' WORK goes into construction of flood protection project involving huge discharge bay, at left, and pump station of unprecedented size providing for nine pumps with total capacity of 13,500 cfs against 29-ft. static head. Erection of trash rack beams has begun in notches of concrete diaphragm walls and piers of pumpintakes at right. Behind cofferdam in left foreground, forms are in place for A-frame bents and piers of fender wall. Looking downstream, steel through-truss spans of Sixth St bridge appear above pump station. In left background is Southern R R bridge across Ohio River.

AFTER more than two years of battling high water and difficult foundation conditions, the Ferd J Robers Construction Co, Burlington, Wis, and the LaCrosse Dredging Corp, Chicago, Ill, joint contractors, have about completed construction for the U S Engineers of a barrier dam and pumping station of unprecedented size to protect Mill Creek valley in Cincinnati from backwater of Ohio River floods. Nearly 3,000 precast concrete piles, most of them driven at 3 on 1 batter in alternate directions to resist pressures from either upstream or downstream support the pump station, floodwalls, fender wall, and a rigid-frame discharge bay 70 ft high through which Mill Creek passes when the Ohio is not in flood. Steel stop-log bulkhead lowered into guide slots of the discharge opening will shut off the valley when the Ohio begins to back up into Mill Creek. At such times the powerful pumps, among the largest in the world, will go into action to lift the Mill Creek flow over the barrier, thus preventing excessive ponding of water behind the dam.

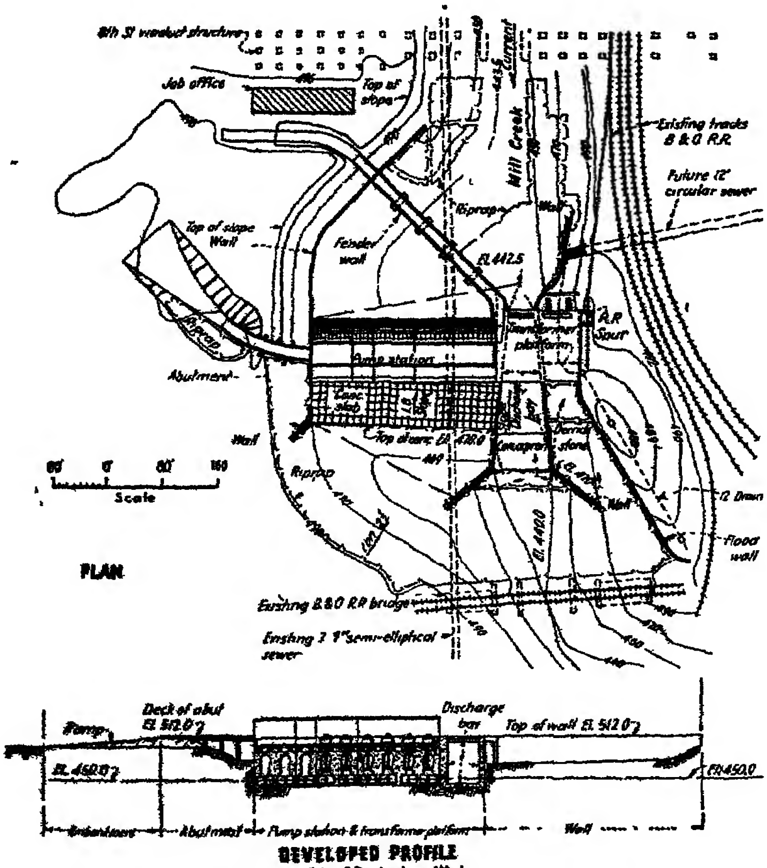
Six cranes played important parts in the successful execution of the work by the contractors. Specially equipped for their various duties, these rigs served in many capacities for dragline and clamshell excavation for driving of concrete piles and steel sheetpiles, for unloading materials, for placing riprap, and for handling reinforcing steel, structural steel and concrete. An accompanying table lists principal contract quantities. Most of the earthmoving work involved in the contract was sublet to the Richter Transfer Co., Cincinnati, which removed 265,000 cu yd. of excavation and hauled in

GANTRY WHIRLEY places 1½ yd bucket of ready-mixed concrete in forms of diaphragm wall for pump discharge outlet on downstream side of pump station. To right of concrete bucket are partially sheathed pump conduit forms set in place above previously concreted pump barrels. Note painter at work on timber bridge riding on craneway rails inside erected superstructure.

MILL CREEK PUMP STATION
Principal Contract Quantities

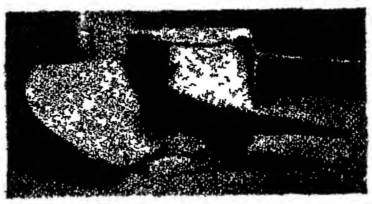
Excavation	265,000 cu yd.
Embankment	21,000 cu. yd.
Compacted backfill	85,000 cu. yd.
Dumped riprap	13,000 cu. yd.
Derrick stone	1,400 cu. yd.
Concrete, class B (5½-bag)	2,000 cu yd.
Concrete, class C (4½-bag)	43,000 cu. yd.
Reinforcing steel	4,850,000 lb
Structural steel	950,000 lb.
Precast concrete piles, battered	59,000 lin. ft.
Precast concrete piles, vertical	18,000 lin. ft.
Steel sheetpiling, battered	9,000 sq. ft.
Steel sheetpiling, vertical	21,000 sq ft.

BEFORE FLUME STOP-LOGS are pulled to flood cofferdam in which concrete piles for discharge bay have been driven, as indicated by arrow, Mill Creek flood passes around west side of cofferdam through diversion channel of 5,000-sec-ft capacity Beyond piledriver on dike, note row of steel sheet-piling protecting railroad embankment at approach to bridge This protection took quite a battering



FLOOD PROTECTION against Ohio River backwater for Cincinnati's Mill Creek valley is provided by pump station and appurtenant walls built by U. S. Engineers with Ferd J. Robers Construction Co. and LaCrosse Dredging Corp. as joint contractors Future construction will extend floodwall eastward to protect low part of city adjacent to creek valley. In present construction, contractors first diverted Mill Creek to west of three-sided cofferdam surrounding discharge bay area. After constructing discharge bay inside this cofferdam, contractors returned Mill Creek to new channel and built second cofferdam to permit construction of forebay, fender wall and pump station.

80-FT. BOOM of 40-ton-capacity crane serves to lift 1½-yd. concrete bucket to great height in 70-ft wall of discharge bay For higher lifts, crane picks up buckets with 16-ft. jib which gives live boom overall reach of 96 ft.



120-IN IMPELLER rests on wood blocking in intake bay, below pump barrel. Driven by 6,500-hp. electric motor, each of these huge pumps can discharge 1,500 cfs against 29-ft. static head.

21,000 cu. yd of material for embankment and 81,000 cu yd. for backfill. The general contractors took care with their own equipment of earthwork for temporary cofferdams and dikes foundations and stream channels Of 2,762 precast concrete piles, 16-in octagonal, totalling 77,000 lin ft in length (an average of 28 ft. per pile), 59,000 lin. ft was driven at 3 on 1 batter and 18,000 ft was put down vertically Under the barrier structures is a continuous steel sheetpile cutoff wall with a surface area of 30,000 sq. ft of which 9,000 sq ft had to be driven at a batter to clear the concrete foundation piles.

An accompanying plan and profile of the pump house and appurtenant works indicate the contours and principal features of the project The pumping station and floodwalls in the present contract are designed to take care of floods to the 80 ft. stage on the Ohio River gage, the

LINES OF WELLPOINTS, indicated by arrows and supplied by Moretrench Corp., control water level in excavated holes for foundations of discharge bay On bank at far right is wellpoint installation paced there to prevent slumping of sand embankment supporting railroad tracks. In background is 8th St. viaduct, highway crossing over Mill Creek valley for U.S 50 and Ohio State Route 264.

BY LOWERING BOOM to incline pin-suspended steel leads, crane drives 16-in. octagonal precast concrete pile at 3 on 1 batter For batter driving, jet pipe travels on guide cable to which it is attached by shackle, cable is strung alongside leads.

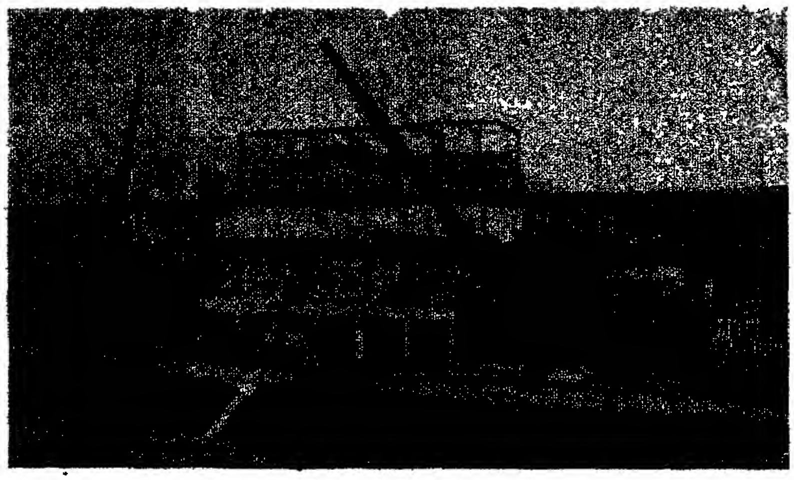
PILE-SUPPORTED TIMBER FRAME guides line of steel sheetpiles being driven at 3 on 1 batter for continuous cutoff wall.

FOR FINAL DRIVING of steel sheetpiles at 3 on 1 batter, steam hammer travels on swinging H-beam leads dropped into ground and inclined by crane at proper angle.

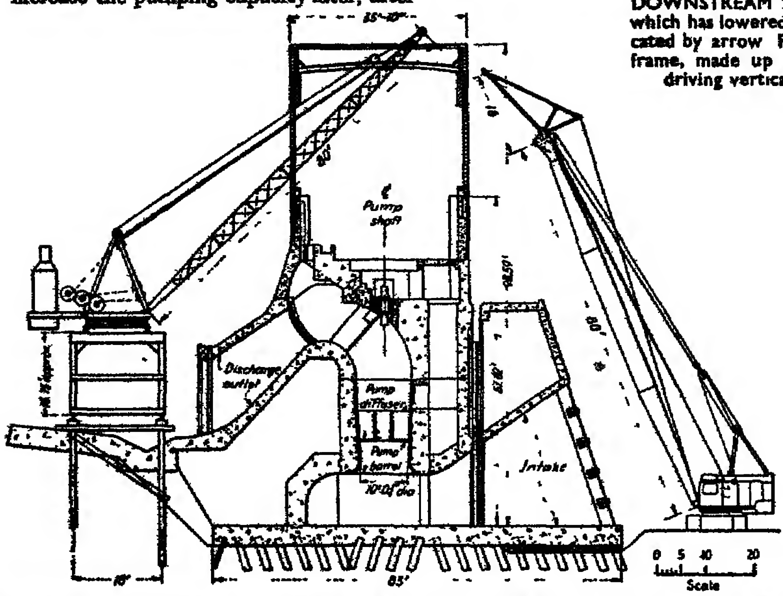
PUMP STATION rests on more than 1,100 precast concrete batter piles driven in alternate directions, upstream and downstream, to resist pressure from either side. Electric arc at centre of exposed foundation piling shows where welder is attaching rod which projects upward into footing slab. Beyond foundation piling form is in place for concreting pump barrel.

maximum recorded flood level reached in 1937. Flood stage on the river gage at Cincinnati is 52 ft. Actually the top of the walls is 83 ft. above zero on the gage, but the present project is effective for the time being only to the 65-ft. stage, which corresponds to the ground level at the extremity of the walls now being completed. Extension of the floodwalls to protect the lower part of the city adjacent to Mill Creek must await future construction.

Mill Creek drains an area of 155 sq mi and is subject to maximum recorded floods of 17,000 sec.-ft., requiring a pump station of huge capacity to handle potential flows when the barrier dam is closed against backwater from the Ohio River During the course of the contract, Mill Creek discharged floods up to 13,000 sec.-ft. Six mammoth pumps are being installed under the present contract and provision is made for three more to increase the pumping capacity later, after



DOWNSTREAM SIDE of pump station is served by gantry whirley, which has lowered concrete bucket for filling by truck-mixer indicated by arrow Pump station superstructure has all-welded steel frame, made up of shop-welded frame units At left, crane is driving vertical steel sheetpile cutoff wall of right abutment.



CONSTRUCTION COVERAGE of large pump station structure is obtained with two long-boom cranes, steam whirley mounted on mobile gantry on downstream side and crawler rig with 96-ft overall reach on upstream side. Latter crane serves also in concreting discharge bay and walls of project.

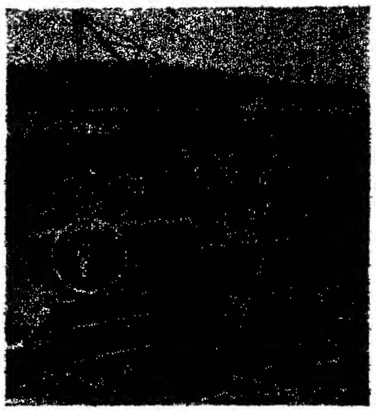
FENDER WALL is made up of reinforced concrete A-frame bents, for which footings have been placed on 50½-ft. centres, and intermediate fender columns, with 10-ft. clear horizontal openings between concrete units.

storage area upstream from the dam has been further depleted by expected filling of the Mill Creek valley The pumps are vertical-shaft, open-impeller, axial-flow type, with 120-in impellers driven by 6,500-hp electric motors, designed and rated for a pumping capacity of 1,500 cfs. against a 29-ft static head. With the Ohio at maximum recorded stage of 80 ft near El 509 above sea level, the pumps will handle their rated capacity when the water level in the forebay of the pumping station stands at El. 480, discharging 9,000 cfs through the barrier with six units in operation. The ultimate installation of nine pumps will be able to take care of 13,500 cfs. against a 29-ft. static head.

Some details of the pump station substructure and superstructure are indicated in an accompanying drawing which shows the arrangement of construction cranes for handling forms, concrete and steel Intakes of the pumps are protected by trash racks supported on horizontal steel beams grouted into the concrete diaphragms between the intakes. The pump station is 270 ft. long Adjacent to the east end is a rigid-frame reinforced-concrete box-type discharge bay, 40 ft wide at the throat Minimum vertical clearance from the top of the footing slab to the underside of the deck slab is 66½ ft The footing slab, resting on battered concrete piles, varies from 9 to 6 ft in thickness, and the deck slab is 3½ and 3 ft thick

To catch logs and other large drift, a fender wall of reinforced-concrete A-frame bents and piers is placed across the upper end of the forebay at an angle with the stream and the pump station Spacing of the fender columns is 10 ft inside to inside horizontal clearances, the bents, on 50½ ft centres, carry the deck of a roadway for trucks and a truck crane used in cleaning debris from the fenders For 20 ft below roadway elevation, El 494 to El 474 the upstream face of the fender structure is closed by a continuous curtain wall

VERSATILE UTILITY UNIT is this tractor crane, mounted on crawler treads, here transporting electric welding set to new location on job



WITH 96-FT REACH from heel of power boom to tip of jib, crane of 2-yd (40-ton) rated capacity handles 1½-yd. concrete bucket into wall forms downstream from discharge bay.

Gravity-Type Walls

Except for the fender wall, all walls are gravity type made up of concrete monoliths bearing on precast piles, both vertical and batter the direction of batter being such as to resist pressures of earth backfill or flood waters against the walls. A continuous cutoff wall of steel sheet piling extends under the right abutment, pump station, discharge bay, and flood wall The cutoff is made up of various sheeting sections, corresponding to U. S Steel Corp. M112, M116, C12A, C12B, and Bethlehem Steel Co DP1, DP2, ST4, CP41 It was possible to instal all the steel sheetpiles vertically except at the south edge of the pump station footing where 200 DP1 piles 32½ ft. long had to be driven at a 3 on 1 batter for the entire length of the station in order to clear battered concrete bearing piles under the same structure.

More than 1,100 concrete bearing piles support the pump station About two-thirds of these piles were driven with an upstream batter and about one-third with a downstream batter The batter bearing piles were a minimum of 31½ ft long and were cut off at El 442 5, which also was the top elevation of all the batter sheetpiling under the pump station.

All concrete piles are designed for 60-ton loading, developed by skin friction in silt and clay Without exception, they developed greater bearing, than the design requirement some of them taking 100 blows to the inch under an 11B hammer delivering effective energy of 22,000 ft -lb per blow In some locations the piles probably picked up additional end bearing value on gravel Some concrete piles were driven with a Vulcan No. 1 hammer, 5,000-lb ram, 15,100-ft -lb blow. A McKiernan-Terry 9B3 and two No 7's were used on the sheeting depending on length and driving resistance

To resist uplift dowel bars projecting from the heads of the concrete piles were welded to bar extensions running well up into the concrete footings. The welders used two portable Lincoln generating sets, a 300-amp, unit driven by gas engine and a 200-amp, powered by an electric motor.

[illegible] Methods

[illegible] of air-water jets concrete [illegible] own at the rate of about [illegible] average of eight to ten per 8 hr. shift. Water was available at 70-lb. pressure from city mains, and this pressure was built up by means of a CH & E four-stage jet pump. A reserve Goulds three-stage pump was rarely used. Air for the jets was furnished by a Chicago Pneumatic 210-cfm. diesel-powered compressor or by a LeRoi unit of the same capacity. Other portable compressors on the job were a Sullivan 160, an Ingersoll-Rand 105, and a Schramm 110. In driving batter concrete piles the jet pipe was suspended alongside the leads by means of a clevis or shackle running on a cable guide fastened at the top to the leads and at the bottom either to the leads or to the pile

Nearly all the concrete piles were driven by a Koehring crane of 2-yd. capacity using contractor-built pin-suspended steel leads and a McKiernan-Terry 11B or 11B3 hammer By lowering and raising the boom, 60 ft. long, the pin-connected leads, joined by right-angle struts to the heel of the boom, could be adjusted to either vertical or batter position. The same crane, with a 10-ft section added to the boom, drove vertical steel sheetpiling without conventional leads, operating a 9B3 hammer on the load line, the hammer was guided by a steel H-beam hung on the bucket-closing line and dropped into the ground beside the sheeting. For batter concrete piles in close quarters, the contractors used timber-and-steel inclined leads which guided both the piling and the hammer on a 3 on 1 slope. Continuous walls of steel sheeting installed at a batter ordinarily were set and driven against wood pile-supported timber frames, as indicated by an accompanying photograph After the piles had been driven to the level of the cap timbers, the frames were removed and driving was continued with the hammer travelling on the H-beam leads, as shown by another picture.

Construction Procedure

In starting construction of the project, the general contractors temporarily diverted the flow of Mill Creek into the elliptical sewer, shown on the plan, capable of carrying 700-sec ft. under no head This diversion facilitated construction of a cofferdam inclosing the discharge bay area The three-sided inclosure consisted of earth embankments with steelsheet pile cores on the upstream and downstream sides and a connecting earth dike between them at the west side. Mill Creek was bypassed through an excavated channel of about 3,000 sec.-ft. capacity to the west of the cofferdam, and the embankment in the west approach to a railroad bridge immediately downstream was protected by driving a wall of DP2 deep-arch-web sheetpiles 45 ft. long. A strong flood estimated at 13,000 sec. ft. severely tested this protection and folded some of the sheetpiles; the bank was held against complete washout with extreme difficulty.

After the discharge works had been completed in the first cofferdam, Mill Creek was returned to the newly constructed channel, and the west half of the project was shut off by steel sheetpile box coffers to enable work to proceed on the pump station. In drying out the excavated holes inside the cofferdams for pile-driving and footing construction, the contractors made use of Moretrench wellpoints, which proved effective in lowering the level of standing water despite the limited perviousness of the silty clay soil. To operate the wellpoints, the contractors had on the job two 8-in pumps (2,000-g p m, capacity) and three 6-in. pumps, one of which always was kept in reserve as a standby unit. Holes were kept dry with 26 self-priming pumps, 8-, 6-, 4-, and 3-in. size, manufactured by Jaeger, Construction Machinery, LaBour and Chain Belt (Rex)

Site Conditions—The site was no picnic ground It had been used for years by the city as a dump, and debris including everything from bedsprings to brickbats had accumulated to a depth of 30 or 40 ft. Under the rubbish, starting at about El. 460, was a deposit of alluvial silt and clay extending to an underlying stratum of sand-gravel at about El. 415

Excavation and Earthmoving

To remove the 265,000 cu yd. of excavation, the subcontractor used three shovels, a Bucyrus-Erie 1½-yd. a Lorain 1½-yd and an Erie ¾-yd. Excavated material was hauled away from the site by a fleet of 4-yd. trucks and by three Koehring 10 yd. Traildumps, pneumatic-tired tractor-trailer outfits. The same equipment served the subcontractor in hauling to the job selected material for

(Continued on page 40.)

AS DISCHARGE BAY approaches stage at which Mill Creek flow can be turned back into this permanent channel, contractors build steel sheetpile box-cofferdam at upstream side, in right foreground, to protect later excavation and construction of [illegible] and pump station.

REINFORCING STEEL IN CONCRETE PAVEMENTS

By R. D. BRADBURY, *Engineer-Director, Wire Reinforcement Institute, Washington, D C.*

USE of reinforcing steel in concrete pavements for highways and airports is no longer prohibited as a wartime conservation measure The peak period of industrial and military emergency construction having passed, reinforcing steel—especially welded wire fabric—is now available in ample quantity to meet all concrete paving needs. Recognizing the present availability of reinforcing steel and the permissibility of its use without jeopardizing the war effort, the War Production Board now permits its use in both highway and airport paving

In view of the fact that engineers have thus recently been permitted to resume their former practice of reinforcing their concrete pavements—even under present wartime conditions—and particularly in view of the detailed plans now being prepared for an extensive programme of post-war highway construction, it is especially appropriate at this time to restate the purpose and structural action of distributed reinforcement in concrete pavements and briefly to review the benefits derived from its use

Basis of Concrete Pavement Design

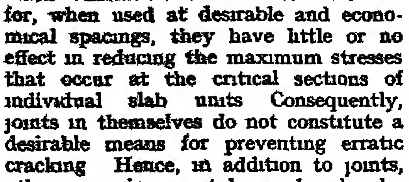
In considering the external conditions to which concrete pavements are subjected, there is a tendency to confine attention only to the effect of heavy traffic loads. While these are, of course, important, still traffic loads alone do not by any means constitute the only source of serious stress development in a concrete pavement slab In addition to the loads applied by vehicular traffic, a concrete pavement is exposed to variations in temperature, variations in moisture content, and frequently non-uniform settlement of the subgrade, or even volumetric changes in the subgrade itself—all tending to deform the slab, and inducing therein stresses of intermittent occurrence and varying intensity. Since merely two of these stress-producing conditions—namely, traffic loads combined with temperature warping—may induce flexural stresses, even in thick slabs of moderate length, of the order of 500 to 600 p s i, and especially since there are other stress producing conditions which can not be anticipated or evaluated, it is obvious that fundamentally there always exists a very grave danger that any concrete pavement may develop erratic cracking at a relatively early age.

Accordingly, the structural design of concrete pavements must be predicated upon the probability of erratic cracking regardless of any slab dimensions that may be provided within limits of reasonable economy. As a matter of practical and economical procedure, it, therefore, becomes necessary to design so as to render expectant cracks structurally harmless by making provision for properly controlling the character of their subsequent behaviour rather than to attempt to preclude all possibility of their occurrence. Thus, it is generally recognized that the basic objective in the structural design of concrete pavements is to attain satisfactory crack control rather than to attempt actual crack prevention.

In thus predicating the structural design of a concrete pavement upon the principle of crack control it is necessary to utilize joints of proper type and spacing But joints serve merely as a means of obtaining a certain degree of crack limitation—not crack control—for, when used at desirable and economical spacings, they have little or no effect in reducing the maximum stresses that occur at the critical sections of individual slab units Consequently, joints in themselves do not constitute a desirable means for preventing erratic cracking Hence, in addition to joints, other provision must be made whereby the subsequent behaviour of any crack that may form will be so controlled as to render the crack structurally harmless This can be accomplished by placing in the slab a well-distributed network of bonded steel which will hold any crack fissure tightly closed

Purpose and Value of Steel

Reinforcing steel, as utilized in concrete pavements, may be classified in two different groups: (a) isolated or widely-separated members, such as dowels, tie-bars, corner bars, and marginal bars, (b) closely-spaced members assembled into sheet form, such as welded wire fabric—a type known as "distributed" reinforcement These must not be confused as to their respective structural functions, since isolated members serve to strengthen only localized sections of the slab, whereas



STRUCTURAL ACTION AT CRACKS IN PLAIN AND REINFORCED PAVEMENTS

(a) As wheel load approaches open crack in plain pavement, loaded slab end carries entire load without assistance from unloaded slab
(b) As wheel load approaches closed crack in reinforced pavement, aggregate interlock renders the crack-joint shear resistant and both slab ends, instead of one, carry the load

the function of distributed reinforcement is to hold tightly closed any cracks that may occur. In this way, the prevalently-used single layer of distributed steel, such as is provided by welded wire fabric, serves as a means of attaining effective crack control in the sense that any incipient cracking, regardless of its cause, is prevented from progressive development When the slab is adequately reinforced, wide open cracks cannot occur, fractured surfaces are held in tight interlock at all times, thereby permitting transfer of load, or, in other words, rendering all cracks shear-resistant Structurally, a single layer of moderate-weight reinforcement thus maintains the original load-carrying capacity of the slab, even after a crack has formed, not by actually increasing the beam strength of the slab section but by maintaining aggregate interlock and making it possible for two crack edges, instead of one, to carry any applied load. It also assures at all times a common surface elevation of adjoining crack edges, thereby minimizing the impact effect of traffic loads Furthermore, distributed reinforcement prevents the development of that dangerous type of crack—the wide crack—which not only lessens the load-carrying capacity of the slab but which, in time, remains permanently open because of dirt accumulation, thereby creating a condition which not only increases the cost of maintenance but also gradually reduces the effective free-width of expansion joints

That distributed reinforcement is both structurally effective and economically justified is not only evidenced by the fact that so many state highway departments have long used reinforcement but has also been conclusively proved by such outstanding research projects as the well-known Bates Road Test and the famous nation-wide pavement survey sponsored by the Highway Research Board and reported under the title "Economic Value of Reinforcement in Concrete Roads" The findings developed by this latter investigation are especially significant since they were based upon the inspection of more than 5,000 miles of concrete highways distributed throughout 26 states Among the many specific conclusions to be found in the official report* of this extensive survey are the following —

1 The data show that steel reinforcement reduced the rate of cracking and thus increased the life of the pavement This applies both to concrete pavements and other pavements laid upon a concrete base
2 Crack reduction is more economically accomplished by the use of steel reinforcement than by additional thickness of concrete
3 A greater reduction was afforded by small steel members closely spaced than by larger members wider spaced

Distributed Reinforcement Design

Since the purpose of distributed reinforcement as used in concrete pavements is to serve as a means of attaining crack control, it is obviously necessary first to limit the size of unit to be controlled by dividing the pavement into slabs of predetermined length through the use of free transverse joints spaced at suitable intervals On the hypothesis that the stress in the steel

* Proceedings, Fifth Annual Meetings, Highway Research Board, Part II.

caused by the tendency for a crack to open is measured by the force developed by subgrade friction when the slab contracts, it follows that, as the slab length is increased, the required amount of longitudinal steel should be increased. Hence, if slabs are made too long, an excessive amount of reinforcement is required On the other hand, if slabs are made very short, only a small amount of reinforcement may be required, but the number of transverse joints in a given length of pavement is unnecessarily increased and an excessive number of such joints is undesirable from the standpoint of both initial cost and maintenance.

The objective of good design, therefore, is to strike a reasonable balance between the spacing of transverse joints and the weight of reinforcement As judged by common practice, experience indicates that satisfactory and economical designs may be obtained when slabs are reinforced in lengths of from 40 to 60 ft

Having chosen the thickness of slab and the spacing of free joints the amount of distributed reinforcement required in either a longitudinal or transverse direction may then be determined by use of the formula

$$A_s = \frac{wcL}{2f_s}$$

in which,

A_s = effective cross-sectional area of steel in square inches per foot width of section

L = distance in feet between free joints (spacing of free transverse joints when computing longitudinal steel, or spacing of free longitudinal joints when computing transverse steel)

w = weight of slab in pounds per square foot

c = average value of the coefficient of subgrade friction

f_s = allowable tensile stress in the steel in pounds per square inch.

The value of c appropriate for use in the above formula is not the absolute maximum as determined by the usual force-displacement test, but should be the average value consistent with slab movement which, of course, varies from zero at the centre of the slab to a maximum at the ends. Tests indicate that, for pavement slabs of thicknesses and lengths as commonly built, a suitable general value for the average frictional coefficient is about $c = 1.5$ for designing the longitudinal steel, and about $c = 1.1$ for designing the transverse steel. The smaller value transversely is permissible because of the smaller slab movement that occurs in the shorter transverse dimension.

Based on a factor of safety of 2 with respect to minimum yield-point values as prescribed by Standard Specifications of the American Society for Testing Materials, appropriate values for the allowable unit stress in the steel, f_s are 28,000 p.s.i for wire fabric, and 20,000 p.s.i. for intermediate grade bars.

Placement of the Steel

Since the structural function of distributed reinforcement as used in concrete pavements is to merely resist the horizontal forces developed by subgrade friction, a rigid requirement for its exact elevation in the slab is of no great structural importance From the viewpoint of its intended purpose, the most logical location of the reinforcement would probably be at the centre of the slab depth But, in view of installation conditions imposed by the best construction procedure, it is not advisable to place distributed reinforcement exactly at the slab centre; since sheet-type reinforcement should always be installed by the so-called "strike-off" method, and it is necessary to make the preliminary strike-off somewhat above the slab centre so that the strike-off template can be freely operated without striking the protruding ends of tie-bars and dowels.

Aside from structural or construction reasons there is some merit in placing the steel as near the top of the slab as possible, since, from the standpoint of both appearance and maintenance, the surface of the pavement is of primary concern. But proximity to the top surface of the slab is limited by requirements for adequate protection and dependable embedment. Hence, the prevailing practice is to place distributed reinforcement somewhere in the upper half of the slab, the most common specification being that it be placed 2 to 3 in. below the top surface—a requirement which should be interpreted as a minimum limit to assure proper coverage of the steel, rather than a rigid specification for exact location

As to the best method of installing distributed reinforcement in concrete pavements, experience has proved that it is both impracticable and structurally unsatisfactory to "chair" sheet-type reinforcement in place before any concrete is poured. Accordingly, it has become universal practice to definitely specify that it shall be installed by the so-called "strike-off" method which consists essentially in pouring the concrete in two separate layers and levelling or striking off the initial pour at the required elevation to form a level bed on which the sheets of reinforcement can be merely laid in place.—(*With acknowledgments to "Concrete".*)

GIANT PUMP STATION GIVES TWO-WAY FLOOD PROTECTION

(*Continued from page 38*)

21,000 cu yd of embankment and 85,000 cu yd of compacted backfill The material was spread by the prime contractors with bulldozer-equipped tractors, four Caterpillars and an Allis-Chalmers, in 6 to 8 in. layers for compaction with LeTourneau and Blaw-Knox sheepsfoot rollers, drawn by the same tractors Two bulldozer-tractors, a Caterpillar and an Allis-Chalmers, were operated by the subcontractor on haul roads and dumps.

For building dikes, filling box coffers and excavating foundations and stream channels, the contractors had five dragline buckets, ¾-yd to 1½-yd., and four clamshell buckets, ½-yd to 1½-yd Five cranes could be used for either clamshell or dragline digging In addition to the Koehring 2-yd. machine already mentioned, the cranes included a Northwest 2-yd (with a long boom and jib especially designed for concrete handling), a Northwest 1½-yd, a Koehring ¾-yd. and a Lima ¾-yd. Material which had to be transported was hauled by the contractors in three tractor-drawn Athey crawler wagons, two 8-yd. and one 10-yd

Concrete Construction

Concrete requirements totalling 45,000 cu yd were supplied to the project by the Richter Concrete Co in 3-yd. ready-mixed batches hauled from a central plant in truck mixers which served as agitators The job was equipped with four 1½-yd. concrete buckets, two Insley and two Blaw-Knox, which were filled from the trucks and handled into the forms by cranes An accompanying drawing show the two principal concreting cranes, a Clyde Wiley whirley mounted on a mobile gantry frame at the downstream side of the pump station and the long-boom-and-jib Northwest unit capable of lifting buckets to fill wall forms 70 ft high. These two cranes handled most of the concrete for the job, with supplementary assistance from the other crawler units.

Forms for exposed concrete surfaces were made up of ¾-in Plycrete-grade plywood or were lined with ¼-in. plywood on ¾-in. wood sheathing The job used 1,500 Universal Spirolock form ties.

Individual pours rarely exceeded 400 cu yd With both the gantry whirley and the long-boom Northwest crane handling concrete buckets, these two units on one day placed 422 cu. yd. around pump barrels in 7 hr. for an average of 62 cu. yd. per hr., which was fairly representative of good progress

Excellent concrete construction resulted from use of a workable mix properly vibrated in the forms The principal vibrators were ten Chicago Pneumatic 417 air-powered units measuring 3 ft. 10 in. overall, with vibrating heads 4½ in. in diameter by 17 in. long These vibrators were supplemented by four smaller units, two Malls, one Master, and one Jackson.

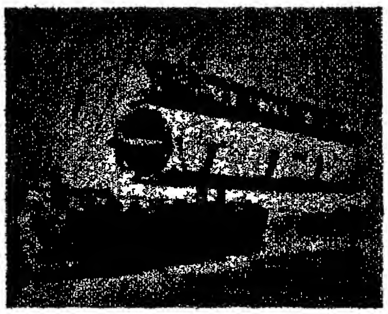
Of the 45,000 cu. yd. of concrete on the job, 43,000 cu yd. was Class C, the normal mix for mass concrete, designed for a compressive strength of 3,200 p.s i. at 28 days Test cylinders ran well over the minimum strength requirement. The coarse aggregate was gravel none of it crushed, in two gradations. Weight proportions per cu yd. were as follows cement, 423 lb , water, 244 lb.; sand, 1,207 lb ; gravel, No. 4 to 1 in., 978 lb.; gravel, 1-in. to 2½-in., 1,207 lb.

One of the most valuable and versatile tools employed on the job was a LeTourneau tractor crane mounted on wide crawlers and operated by a Caterpillar RD6 tractor. This crane handled all kinds of equipment and materials around the project. It could lift its load about 20 ft. above the ground. For occasional use the constructors had also another LeTourneau unit of about the same size and a contractor-built tractor crane with a 35-40-ft. lift.—(*With acknowledgments to "Construction Methods."*)

PRE-STRESSED WIRE

in Reinforced Concrete Tanks and Pipes

THE researches of the French engineer, Freyssinet, and other workers in Europe on the use of pre-stressed reinforcement in concrete work have been known for years by structural engineers. They established the fact that prestressing of mild steel rods became ineffective in course of time through the shrinkage and plastic flow of the concrete. The yield point of mild steel also places limits on the degree of its prestressing. With hard drawn steel wire, however, the ultimate strength is greatly increased and the yield point follows close to the ultimate strength. The use of this reinforcing material, in place of mild steel rods, therefore permits a high degree of prestressing that will still retain a substantial and effective residue of stress after volume adjustments have taken place in the concrete.



LIFTING 6-FT. DIAMETER CONCRETE PIPES.

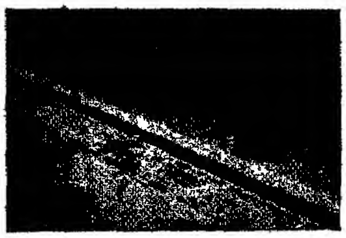
For the outfall from the Coney Island sewage treatment plant in New York it was desired to reduce the number of joints required to be made tight under water and the contracting company fabricated pipes 6-ft. in diameter and 24-ft. in length, the weight of each pipe length being 22 tons. The wall thickness was 7 inches and the reinforcement consisted of an inner and outer cage of spirally-wound wire welded to ½-in longitudinal rods. The bell and spigot joints were made with galvanised steel rings welded to the longitudinal reinforcement. The spigots were grooved to receive a ⅞-in round rubber gasket which provides a watertight yet flexible joint. The pipes were cast with their axes in the vertical position, the steel forms being set on a cast-iron base ring. The concrete was vibrated in the forms and steam-cured.

The necessity for reducing steel consumption has prompted wartime developments of these principles in the United States. The Preload Company of New York has devised a method of winding commercial grades of wire around concrete tanks and developing initial stresses of 150,000 lb per square inch on wire having a yield point of 185,000 lb per square inch. It is considered that the resultant stress after concrete shrinkage will be about 110,000 lb per square inch. This method also prestresses the concrete in compression and, in practice, the prestressing and spacing of the wire can be adjusted so that no tensile cracks will occur in the tank walls under full internal hydrostatic pressure.

The prestressing is carried out during the operation of winding the wire around the concrete tank wall. The equipment for this purpose is carried on a platform suspended from a carriage running around the top of the wall. The saving in weight of steel over that of a tank reinforced with mild steel rods may amount to as much as 75 per cent. An outer coat of cement mortar is applied pneumatically and serves to anchor as well as to protect the wire.

In Washington, D.C., a contract for the construction of 75,000 lineal feet of 30-inch reinforced concrete water pipe has been carried out by the Lock Joint Pipe Company, employing a prestressed wire system of reinforcement which showed a saving of 1,000 tons of steel over a pipe using normal reinforcement but otherwise similar in design. This pipe follows the company's practice of a centrifugally-placed concrete lining inside a sheet steel shell, with an outer reinforcing spiral and mortar coating. The pipes were manufactured on the job. The steel shell is of 16 gauge and arrives in flat sheets sized so that three of them, welded together form a complete shell, which is also welded to the end joint rings. After the concrete lining is placed by the centrifugal method it is steam cured and the interior honed with abrasive stones to remove any surface irregularities.

At this stage the pipe is stiff and strong enough to receive the prestressed wire reinforcement which is wound under tension directly over the steel shell. The high tensile wrapping wire is of No. 6 gauge (0.192 in. dia.) and is given a gross tension of 3,000 lb., equivalent to 86,000 lb. per sq. in., its minimum tensile strength being



LONG CONCRETE VIADUCT

This elevated concrete roadway was built at a cost of about £A1,200,000 to carry a main highway above flood level across the Morganza Floodway in Louisiana. Its total length is 3½ miles. The structure is 50 feet in width and is supported, at intervals, on concrete bents formed from rows of reinforced concrete piles having an average length of 85 feet.

185,000 lb. per sq. in. The design provides that the concrete lining will always be in compression when the pipe is in service.

The mortar coating is fed to a pair of rapidly rotating wire brushes, turning together in opposite directions, which throw the mortar with great force against the rotating pipe. For protection while setting, a strip of loosely woven cotton fabric is wound on, following up the mortar coating. The latter is finally steam cured, and the pipe is ready for laying five days after its manufacture.

The pipe was designed for heads ranging from 384 to 480 feet. A completed pipe under test failed at 725 lb. per sq. in., equivalent to 1,665 ft. of head. Another pipe without the mortar coating failed at 625 lb. per sq. in. Bending strength tests on the pipe also proved highly satisfactory.—(*With acknowledgments to "Building and Engineering"*)

POROUS CONCRETE PIPES

THE Bureau of Reclamation of the United States Government has prepared a specification for porous concrete drainage pipes. This stipulates that the concrete shall be mixed in the proportions of 1 part of Portland cement to 5 parts of pea gravel by weight, the amount of water being such that the resulting cement paste will not fill the voids in the aggregate but will thoroughly coat and bind the aggregate particles together; this consistency is obtained with a water-cement ratio of about 0.33 by weight.

The aggregate is required to pass a screen having ⅜-in. round openings and to be retained on a screen having 3/16-in. round openings. The material must be properly screened so that no particles less than 3/16 in. are present, as it has been found that even 2 per cent of undersized material seriously reduces the porosity of the concrete.

To prevent the cement from "lumping" and accumulating on the blades and sides of the mixer, it is recommended that most of the gravel and water be first charged into the drum and the drum revolved until any coating left from the previous batch is removed, and the remainder of the water and aggregates and the cement then introduced into the drum.

The compressive strength required is 1,000 lb. per square inch at seven days on 6-in. by 12-in. cylinders.

The porosity is to be such that 7 gallons of water per minute will pass through a square foot of porous concrete 12 in. thick when the depth of water on the slab is maintained at 4 in. during the test.—(*"Concrete Building & Concrete Products"*)

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GYRATORY CRUSHERS,
DISC CRUSHERS,
ROLL CRUSHERS,
GRANULATORS,
PAN FEEDERS,
LIVE ROLL GRIZZLEY,
ELEVATORS AND SCREENS.

Fitted with

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MANGANESE STEEL

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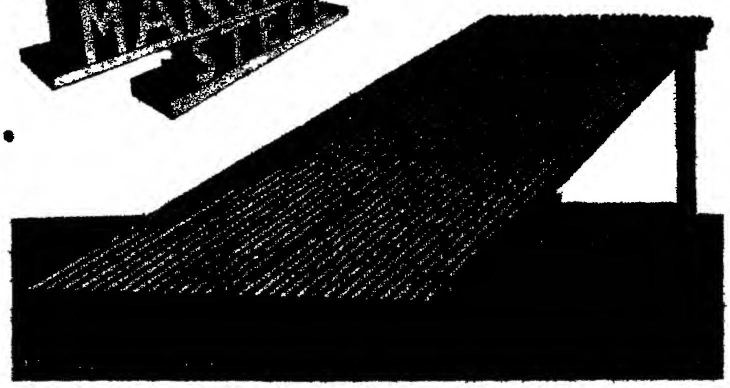

GRIZZLEYS BUILT UP OF ROLLED BARS OF HADFIELDS PATENT "ERA" MANGANESE STEEL.

Balmer Lawrie & Co. Ltd.
CALCUTTA & BOMBAY.
Representatives for

HADFIELDS LTD.

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SHEFFIELD,
ENGLAND.

BIRD & CO., Lahore, New Delhi & Cawnpore

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Who are the Distributors of: A. C. C. & DALMIA Cements

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ABBOTTABAD
R. S. Havelian
ABDUL HAKIM
ABOHAR
ADAMPORE DOABA
AHMADGARH
AKALGARH
ALAL
ALACHOR
AMRITSAR
ARIFWALA
ATARI
BADAMI BAGH
BAIJNATH PAPROLA
BADDOMALHI
BAHRAM
BAHAWALNAGAR
BAHAWALPUR
BANGA
BANNU
BARIWALA
BATALA
BEGOWAL GHARTAL
BEAS
BHAGTANWALA
BHAKKAR
BHALWAL
BHATINDA
BHAUN
BHERA
BHOGPUR SIRWAL
BASSI PATHANAN
BASAL
BASIRPUR
CAMBELLPUR
CHAK JHUMRA
CHAK AMRU
CHAK KANBO
CHAKWAL
CHAWINDA
CHAMANWALA
CHANGAMANGA
CHENAB WEST BANK
CHHEHARTA
CHICHAWATNI ROAD
CHINIOT
CHISHTIEN
CHUHARKANA
CHUTIANA
DALHOUSIE
R. S. Pathankot.
DAULATALA
DASKA
DASUYA
DERA BABA NANAK
DERA ISMAIL KHAN
R. S. Daryakhan.
DERA GHAZI KHAN
DERA NAWABSAHIB
DARBARSAHIB KARTARPUR
DHARAMPUR
DHARIWAL
DHILWAN
DHUDIAL
DHURI
DHABAN SINGH
DINA
DURGAI
DINANAGAR
DINGA
DORAHA
DUNGA BUNGA
DUNYAPUR
EMINABAD
FARIDKOT
FATEHGARH CHURIAN
FAZILKA
FATEJANG
FEROZEPUR CITY & CANTT
GARHSHANKAR
GAKHAR
GAZIGHA
GHAGGAR
GIDDARBAHA
GONIANA
GORAYA
GUJARKHAN
GOBINDGARH
GOJRA
GUJRANWALA
GUJRAT
GUL IMAM
GURDASPUR
GURU HARSAHAI
GUNJAYAB
HAFIZABAD
HARUNABAD
HARIPUR HAZARA
HASILPUR
HIRA SING
HOSHIARPUR
HARAPPA ROAD
HASAN ABDAL
ISAKHEL
INJRA
JAGRAON
JAHANIA
JAIJON DOABA
JAMMU
JALALABAD
JALLO
JAITU
JANDIALA
JANIWALA
JARANWALA
JHANG MAGHIANA
JHELUM
JOGINDERNAGAR
JULLUNDER CITY & CANTT
JUTOGH
JWALAMUKHI ROAD
KHEWRA
KABUL
R. S. Chaman & Peshawar
KABUL RIVER
KAMALIA
KALAKE
KALKA
KALABAGH
KALLUR KOT
KAMOKE
KANGANPUR
KANGRA
KAPURTHALA
KARTARPUR
KAROR
KASAULI
R. S. Kalka.
KHUSHAB
KASUR
KHANEWAL
KHAROR PAKKA
KOT RADHAKISHEN
KANDAGHAT
KUNDIAN
KHANNA
KHANPUR
KHASA
KOT ADU
KHARIAN
KILA RAIPUR
KOHAT
KOT KAPURA
KOT LAKHPAT
KURALI
LAHORE & LAHORE CANTT
LAKHEWALI
LAKI MARWAT
LALAMUSA
LALIAN
LODHRAN
LOHIAN KHAS
LEIAH
LUDHIANA
LYALLPUR
MACLEOD GUNJ ROAD
MAGHARWAL
MALISI
MAJITHA
MALAKWAL
MALERKOTLA
MAKHU
MALOUT
MALSIAN SHAHKOT
MANDI BAHAUDDIN
MANSA
MARH BALOCHAN
MANDI BUREWALA
MANDI STATE
MANGWAL
MARDAN
MAMU KANJAN
MAUR
MAINWALI
MIRPUR
R. S. Sarai Alamgir
MIRAN SAHIB
MOGA
MOGHALPURA
MONTGOMERY
MORINDA
MUKERIAN
MUKTSAR(S.B & C.L.)
MULLANPUR
MULTAN CITY & CANTT.
MURREE
R. S. Rawalpindi.
MUZZAFFARGARH
MURIDKE
MINCHINABAD
MIRAN SAHIB
NAKODAR
NANKANA SAHIB
NARANG
NAROWAL
NAWANSHAHR DOABA
NOWSHERA
NURKOT
NURMAHAL
NURPORE ROAD
NAGROTA
OKARA
PALAMPUR
PARACHINAR (*Via Thal*)
PASRUR
PATHANKOT
PAKPATTAN
PATTI
MIANCHANNU
MINCHINABAD
PINDIGHEB
PATTOKI
PESHAWAR
PHAGWARA
PHILLAUR
PHULLERWAN
PIRMAHAL
PIND DADAN KHA
PIPLAN
QADIAN
QILLA SHEIKHU-PURA
QILA SOBHA SINGH
RAHON
RANBIRSINGHPURA
RAIKOT (*R. S. Mullanpur*)
RAHWALI
RAIWIND
RAHIMYARKHAN
RAJA JANG
RORANWALA
RAWALPINDI
RENALA KHURD
RUPAR
RANBIR SINGH PURA
SADIKABAD
SAMBRIAL
SAILA KHURD
SANAHWAL
SANGLA HILL
SILLANWALI
SARAI ALAMGIR
SARGODHA
SARNA
SATNAUR BADE-SRON
SHAH ALAM
SHAHDARA
SHARAKPUR
(R. S. Shahdara)
SHAHPUR SADAR
SHAH CHAURASI
SHORKOT ROAD
SHUJABAD
SIALKOT
SIHALA
SIMLA
SIRHIND
SOLON
SUKHO
SULTANPUR LODHI
SUKHEKE
SRINAGAR
R. S. Havelian or Rawalpindi
TALAGANG (*R. S. Chakwal*)
TALWANDI
TARN TARAN
TANDA URMAR
TANDIANWALA
TANK
TAXILA
THERI SANSI
TEHSIL SHAKAR-GARH
THABALKE
THAL
TODA TEK SINGH
VEHARI
VERKA
WAZIRABAD
WARBURTON
WASAWEWALA

NEW DELHI AREA :—

AGRA
ALAL
ALIGARH
AMROHA
AMBALA CITY
AMBALA CANTT
ATRAULI ROAD
BABRALA
BARHAN
BARARA
BARNALA
BAGHPAT ROAD
BAH (*R. S. Belanganj*)
BAHADURGARH
BAHJOI
BARETA
BASIKIRATHPUR
BAGAMABAD
BHIWANI
BHUCHCHU
BALLABGARH
BARAUT
BUDHLADA
BULANDSHAHR
BIJNOR
BRINDABAN
CHANDAUSI
CHANDPUR SIAU
CHOLA
DADRI
DALMIA-DADRI
DIBAI
DEHRA DUN
DELHI
DELHI SHAHDRA
DEOBAND
DANKAUR
DAURALA
DHAMPUR
DHANARI
DOIWALA
ETMADPUR
FARIDABAD
FEROZABAD
GAVAUR
GANGOH
GARHMUKHTESAR
GHAZIABAD
GHARAUNDA
GOT
GOHANA
GURGAON
GULAOTHI
HALDAUR
HANSI
HARDWAR
HAPUR
HATHRAS
HISSAR
HASANPUR (*R. S. Gajraula*)
JAGADHRI
JAKHAL
JALESAR ROAD
JAWALAPUR
JIND CITY
JULANA
KALANWALI
KANTH
KANDHLA
KAURARA
KHATAULI
KHEKRA
KHURJA
KARNAL
KAITHAL
KASHIPUR
KASIMPUR KHERI
KOSI KALAN
KOTDWARA
KURUKSHETRA
LEHRAGAGA
LHAKSAR
LOHARU
MANDI DHANAURA
MADLAUDA
MANSURPUR
MEERUT
MILAK
MORADABAD
MUNDLANA
MURADNAGAR
MURSAN
MUTTRA
MUZAFFARNAGAR
NAJIBABAD
NAGARIA SADAT
NAGINA
NABHA
NANAUTA
NARELA
NARWANA
PALWAL
PANIPAT
PATIALA
PILKHUWA
RAIWALA
RAJA-KA SAHAS-PUR
RAJGHAT-NARORA
RAJPURA
RAMAN
RAMNAGAR
RAMPUR
RAMPUR MANHYA-RAN
RAMPURA PHUL
RAYA
REWARI
ROHTAK
ROORKEE
RIKHIKESH
SAFIDON
SAHARANPUR
SAMPLA
SANGRUR
SASNI
SUNAM
SAMALKHA
SAMBHAL HATIM SARAI
SARSAWA
SEOHARA
SHIKOHABAD
SHAHABAD MAR-KANDA
SHAMLI
SIRSA
SONEPAT
SIMBHAOLI
TAPA
TAPRI
THANA BHAWAN
THANESAR
TUNDLA
TOHANA
UCHANA
UKLANA

CAWNPORE AREA :—

ACHALGANJ
ACHHALDA
AGSAULI
AHIMANPUR
AHRAURA ROAD
AJGAIN
AJODHYA
AKBARPUR
ALIGANJ
ALLAHABAD
AMETHI
AMOUSI
ANJHI
ANUPGANJ
AONLA
ASANPUR
ATARRA
AURAIYA
AUNKHAR
AZAMGARH
BABHNAN
BACHRAWAN
BADSHAHPUR
BAHERI
BAHRAICH
BAHRAMGHAT
BAISWARA
BAITALPUR
BAKSHA
BALAMAU
BALLIA
BALRAMPUR
BAMIANA
BANDASSA
BANDA
BANGAR MAU
BARA BANKI
BAREILLY
BARHAJ BAZAR
BARHNI
BARAHALGANJ
BASAI
BASHARATGANJ
BASTI
BELLARIEN
BELTHARA ROAD
BENARES CANTT
BENARES CITY
BEWAR
BHADOHI
BHARTHANA
BHATPARRANI
BHATNI
BHITAURA
BHITI
BHONGAON
BIJAURIA
BILGRAM
BILPUR
BINDKI ROAD
BISALPUR
BISWAN
BODARWAR
BRIDGMANGANJ
BUDAUN
BURHWAL
CAMPIERGANJ
CAPTAINGANJ
CAWNPORE
CHANDAULI MANJHWAR
CHANDWAK
CHAURICHAURA
CHHITAUNI
CHHIBRAMAU
CHILBILA
CHILH
CHILWARIA
CHIRGAON
CHIT-BARAGAON
CHOWKAGHAT
CHUNAR
COLONELGANJ
DARYABAD
DARYAOGANJ
DATIA
DHEENA
DIBIAPUR
DILDAR NAGAR
DOBHI
DOHRIGHAT
DULAHPUR
ETAH
ETAWAH
FARRUKHABAD
FATEHGARH
FATEHPUR
FYZABAD
GAHMAR
GANJDUNDWARA
GAURIGANJ
GHAZIPUR
GHOSI
GHUGHLI
GOLA GOKARAN-NATH
GONDA
GORAKHPUR
GOSHAINGANJ
GURSAHAIGANJ
HAIDARGARH
HALDWANI
HANDIA KHAS
HARDOI
HARGAON
HARNAMGANJ
HARPALGANJ
HARPALPUR

Cawnpore Area (Contd.)

JAHANAGANJ ROAD
JAIS
JAKHANIA
JALALPUR
JANGHAI JN
JANGIGANJ
JARWAL ROAD
JASWANTNAGAR
JAUNPUR
JEONATHPUR
JHANSI
JHUSI
KABRAI
KACHHLA GHAT
KACHHWA ROAD
KADIPUR
KAIMGANJ
KALPI
KAMALGANJ
KAMALPUR
KANAUJ
KANCHAUSI
KARARI
KARENGI
KARWI
KASGANJ
KASHI
KATHGODAM
KATHKUIYAN
KATKA
KAWAPUR
KEORIPUR
KERAKAT
KHADA
KHAGA
KHALILABAD
KHATEMA
KHETA SARAI
KHORASAN ROAD
KICHHA
KIDIRDAPUR
KORNDAUR
KONRH ROAD
KOPAGANJ
KUNCH
KUNRAGHAT
KUSMHI
LACHHMIPUR
LAKHIMPUR KHERI
LAKSHMIGANJ
LALGANJ
LALITPUR
LAR ROAD
LUCKNOW
MADHOGANJ
MADHOSINGH
MAHMUDABAD
MAHOBA
MAHOLI
MAHPUR
MAINPURI
MAKRANDPUR
MALIHABAD
MALIPUR
MALLAWAN
MANAURI
MANDAH ROAD
MANKAPUR
MANPUR NAGARIA
MARHERA
MARIAHU
MASKANWA
MAU AIMA
MAU NATH BHANJAN
MAURANIPUR
MEJA ROAD
MIRANPUR KATRA
MIRZAPUR
MISRIKH TIRATH
MOGHAL SARAI
MOTH
MUHAMMADABAD GOHNA
MUNDERWA
MUSAFIRKHANA
NAGARIA SADAT
NAIPALGUNJ ROAD
NANDGUNJ
NANPARA
NAUTANWA
NAWABGUNG GONDA
NIBKARORI
NOWGARH
ORAI
ORCHHA
PACHPERWA
PADRAUNA
PARIAWAN
PARTABGARH
PATIALI ON-GANGES
PAYAGPUR
PEPPEGANJ
PHAPHUND
PHARENDA
PHARIHA
PHEPHNA
PHULPUR
PIPRAICH
PITAMBERPUR
PILIBHIT
PUKHRAYAN
PUNCH
PURANPUR
RAGAUL
RAGHURAJ SINGH
RAI BARELI
RAJA KA-RAMPUR
RAJA TALAB
RAJAWARI
RAMKOLA
RANI KI-SARAI
RASAULI
RASRA
RASL LABAD
REOTI
RICHHA ROAD
RISIA
RUDAIN
RUDAULI
RURA
SAADAT
SAFDAR GANJ
SAFIPUR
SAHATWAR
SAHAWAR TOWN
SAHJANWA
SAIDPUR BH ITR
SAIYEDRAJA
SAKALDIHA
SALIMPUR
SANDILA
SARAIMIR
SARDARNAGAR
SARJU
SHAHGANJ
SHAHGARH
SHAHJAHANPUR
SHAMSHABAD
SHEIKHUPUR
SHIVPUR
SHOHRATGARH
SHRI KRISHNA NAGAR
SIDHAULI
SIKANDARPUR
SIKANDRA RAO
SISOTARGHAT
SISWA BAZAR
SITAPUR
SORON
SULTANPUR
SURAIMANPUR
SURIAWAN
TAHSIL DEORIA
TAHSIL FATEHPUR
TAKIA
TAMKOHI ROAD
TANAKPUR
TANDA
TARAON
TARIGHAT
TILHAR
TIKRI
TULSIPUR
UJHANI
UNAO
UNCHAULIA
USKA BAZAR
WALTERGANJ
YADVENDRA NAGAR
YUSUFFUR
ZAMANIA

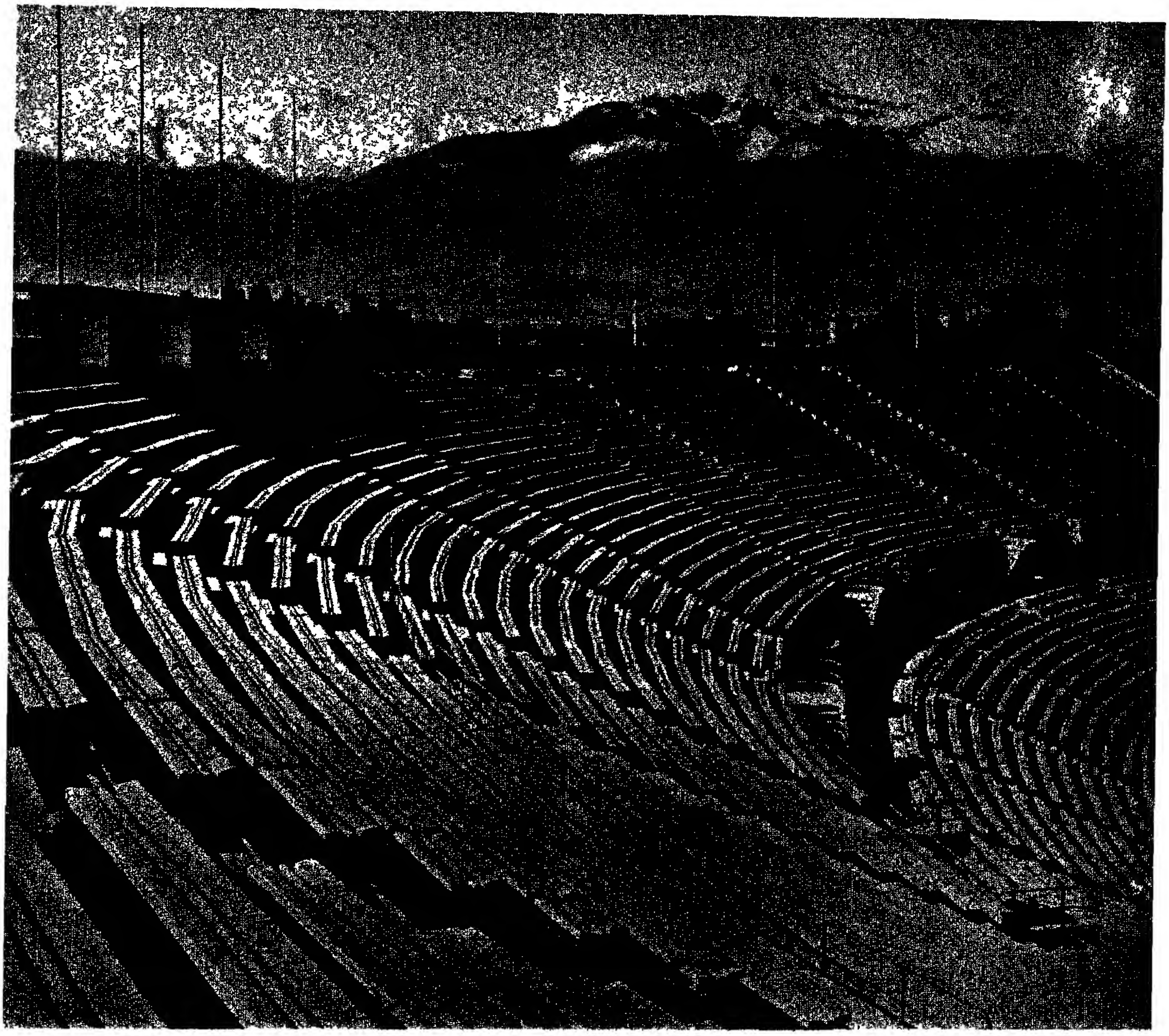

Photo Fenno Jacobs, Three Lions New York.

THE NATIONAL STADIUM IN SANTIAGO, CHILE — ONE OF THE FINEST IN SOUTH AMERICA HOLDING 80,000 PEOPLE

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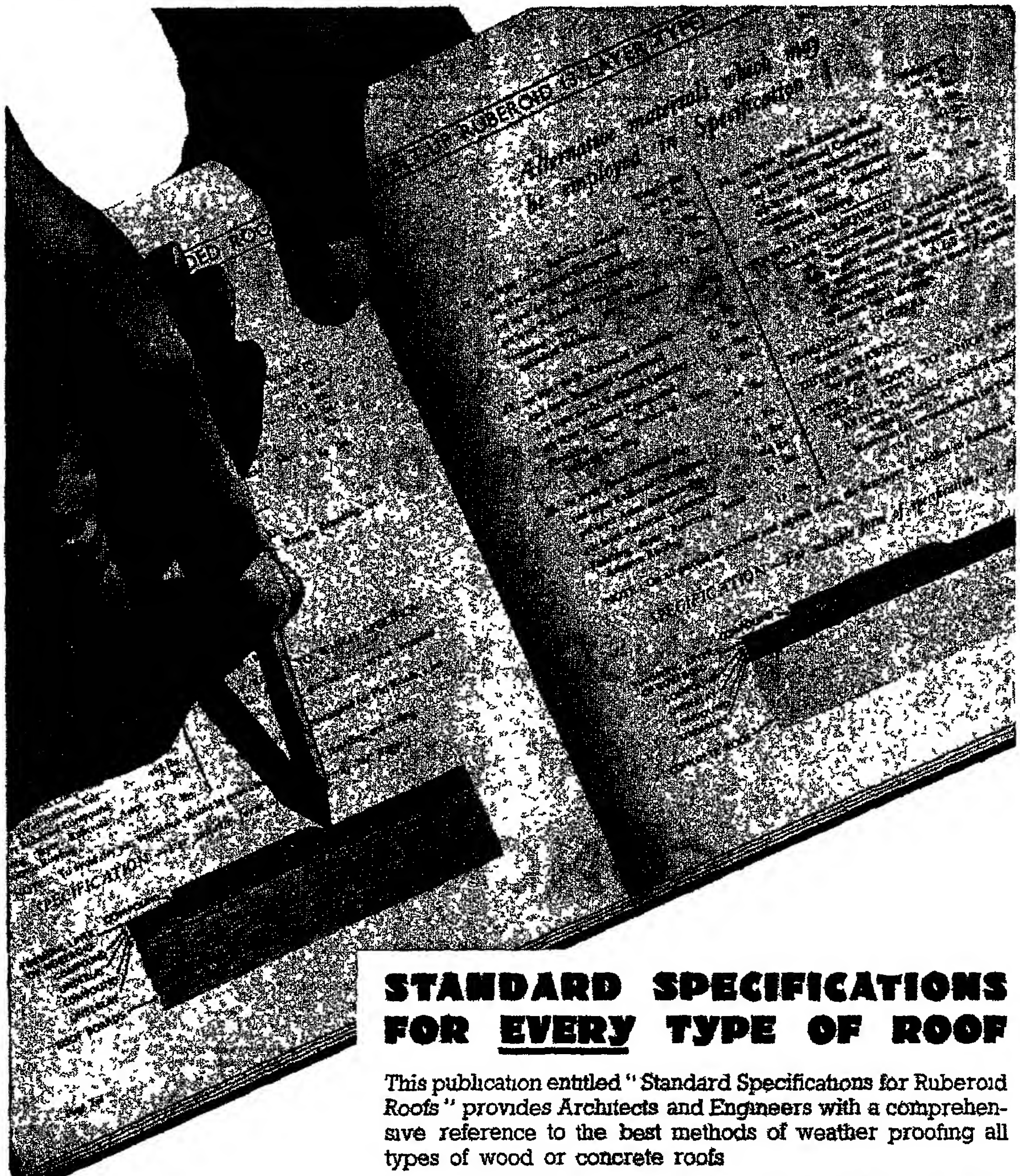
The INDIAN CONCRETE JOURNAL

VOLUME XIX APRIL 1945 NUMBER 4

ARTIST'S CONCEPTION OF NARROW CONCRETE ROADS WITH EARTH BERMS



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NOTE —*Pages 356 to 378 are in January 1944 issue.*

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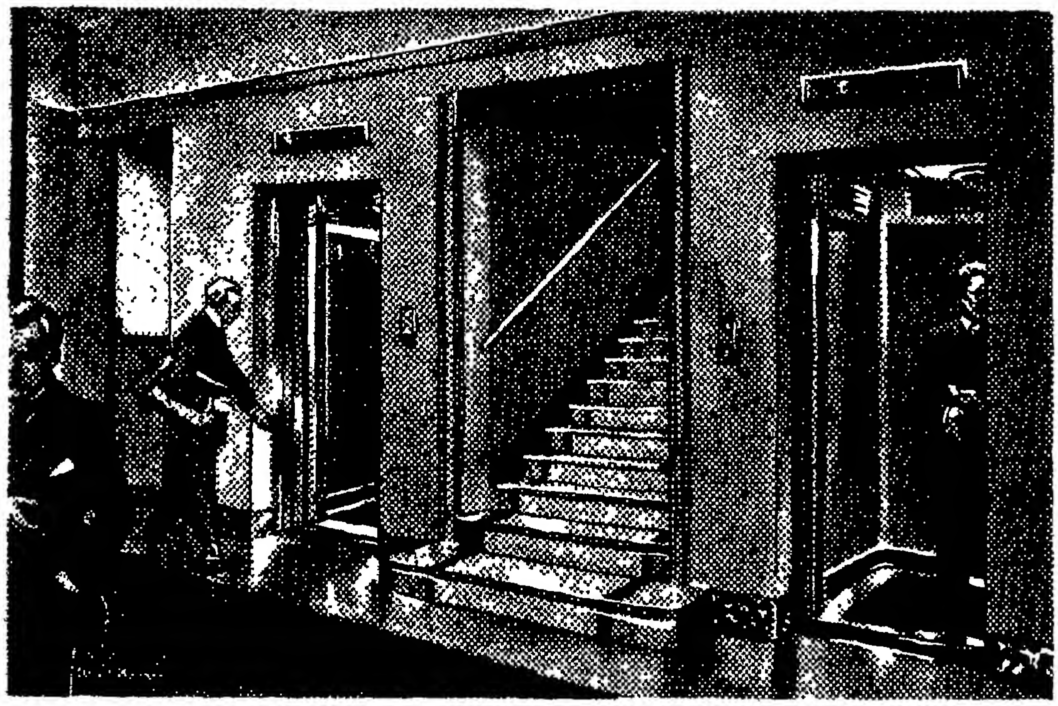

April 15th, 1945

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ASST. TECHNICAL EDITOR —
H. S. Bediwala, B.E., M.I.E. (India), M. I. Struct. E., M.I.H.E. (London).

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EDITORIAL NEWS & NOTES

FOOD AND IRRIGATION

Problems affecting India in General and Bombay in particular

Presidential Address by Rao Bahadur N. S. Joshi, Chairman of the Bombay Centre of the Institution of Engineers (India), Bombay, 19th January 1945.

INDIA as a whole is deficit in food-grain by 1.5 million tons her normal annual production being 51.5 million tons. The population of India today is about 390 millions and this will increase to over 500 millions after 30 years The shortage in food-stuff will then be 16.4 million tons, the annual normal requirements then being 67.9 million tons with the same standard of nutrition as that of today. Actually not only is the quantity available at present per head far too insufficient (18 ozs. of grain against 27 ozs necessary to supply the heat energy necessary for healthy life) but what little is available is not nutrious being unbalanced. India will not be able to hold her own in the struggle for life unless the population is fed better.

Larger quantities of food will need larger areas to be cropped. India has under plough at present about 340 million acres of land including current fallows Besides this, there are 230 million acres of culturable land, but this latter is situated in tracts of very poor rainfall or with other difficult environments with the result that it cannot be cropped ordinarily, *i.e.*, unless irrigation by canals, wells or tanks could be provided. Even in the case of lands already being cropped annually, the outturn can be increased to 3 times by irrigation and manuring. It has to be remembered, however, that manuring cannot be adopted without irrigation. The main method of obtaining larger quantities of food is, therefore, by providing water for irrigating lands. India irrigates at present about 64 million acres, *i.e.*, about 23 per cent of its cropped area. It is estimated that if the population is to be given sufficient food, we must provide irrigation facilities to 125 million acres in addition to 64 million acres being irrigated at present

These figures are worked out after making allowance for increase possible by improved seed and other methods of culture. If we aim at a balanced diet, the extent of lands to be brought under irrigation will have to be even larger. Roughly speaking India will have to spend about 1,500 crores of rupees to provide increased quantities of food to allow the minimum calories required for life. If a balanced diet is aimed at, the capital expenditure on irrigation works will be about 2,000 crores of rupees.

Irrigation works are of 3 types mainly: (1) Large Canals, (2) Tanks and (3) Wells.

Out of the 64 million acres irrigated at present large canals cater for 33 million, wells for 16 million and tanks for 8 million acres To get 125 million acres more under irrigation the area under each of these 3 types will have to be increased.

India's irrigation works are at present distributed very unevenly, the Punjab, the U P. and Madras having 16, 11 and 9 million acres each respectively out of the total of 64 million acres irrigated annually. Except for Sind and Bihar which have about 7 million acres irrigated each, the remaining provinces have very small areas under irrigation. Bombay, which we will study in a little more detail, irrigates just about 1 million acres only annually

Out of the total of 11 lakh acres about 2 lakhs are irrigated under large canals, about 3 lakhs by small tanks and canals and the remaining 6 lakhs by wells. It need hardly be recorded that wells are constructed by private capital by individual owners, while a major portion of canals and tanks have been constructed by Government. Out of the total Government owned works irrigating 5 lakhs of acres, works irrigating about 2½ lakhs of acres, were constructed by the present Government and the remaining by pre-British Governments.

Bombay has a total of about 28 million acres sown annually. The additional area that can be brought under the plough is small. The irrigated area, *viz.*, about 1 million acres forms just about 4 per cent only of the annually sown area. This is very small indeed as compared with Provinces like Sind, the Punjab, the U.P. and Madras which irrigate 86, 59, 32 and 27 per cent. of their lands respectively. Not that Bombay does not need more canals and other irrigation works but they are very costly here due to Bombay's topography and the hard Deccan trap which is very costly to cut through While it requires only rupee 1 of capital on the construction of canals for 1 rupee of annual produce in the Punjab, Bombay requires 8 rupees as capital on the construction of canals and tanks for 1 rupee worth of annual produce. Even so Bombay must increase her irrigated area from 1 million acres to at least 5 million acres if she is to supply a properly balanced diet to her population 30 years hence. Bombay's existing population is about 20 millions and this will be 26 millions after 30 years As against 4.5 million tons of cereals and pulses and 6 million tons of total food she consumes at present, her requirements will be 5.7 million tons of cereals and pulses and 8 million tons of total food after 30 years, if there were no change in the standard of nutrition. The requirements will be 3.4 million tons of cereals and 4.6 million tons of superior food (in all 8 million tons) with a balanced diet It has to be noted that even for the existing population Bombay has to import about 1 million tons of food-grain to supply the existing unbalanced diet to her population.

The only possible way to provide for this, is by increasing the area under irrigation from 1 million acres at present to 5 million acres. The question is, how is this to be achieved ?

It may be explained here that even if food-grain could partly be imported, this increase in irrigated area will still be necessary to allow Bombay to supply commodities like cotton, sugar, gul or oils in return for food to the Provinces exchanging this with grain.

The irrigation works of Bombay can be divided into 4 types The following table gives information about each type and the increase in irrigation possible in each. Capital required to be invested on each type and the probable return are also shown

	Ghat-fed Tanks.	Up-country tanks	Small tanks.	Wells	Total in round Figs.	
	1	2	3	4		
Existing No.	6	37	11,000	5 lakh		No.
Area irrigated at present.	2	½	2½	6	11	lakh acres
Increase possible in practice.	8 (10)	1	3	30	42 (44)	lakh acres
Capital cost for the proposed increase	35	2	7	114	158	Crore Rs.
Return on Capital	6½	2	3	1½	3	%

Regarding the area irrigated by ghat-fed tanks and canals, it has to be explained that the area of 8 lakhs is possible only by working on economic lines, *i.e.*, giving up the present method of isolated and petty indivisual sanctions. The upper reaches under command will have to be earmarked for Industrial, or co-operative large scale irrigation and the lower reaches will have concentrated block irrigation work. With such an arrangement, the canals can be lined in the upper reaches and made watertight. The water thus saved may allow the area to be irrigated to increase from 8 to 10 lakhs of acres. With improvement on these lines, these works can

be made productive instead of their showing a return which is smaller than the rate of interest on capital as at present. Our total increase in irrigated areas will then be more than 44 lakhs of acres. There are 3 very important facts to be noted and which involve questions of national economy. Irrigation works under type No. 1, *viz*, ghatfed tanks and canals are like goldmines really and can give extremely nice results if worked economically and waste avoided. Isolation due to sanctioning irrigation to small individual holdings are like moth in this high class satin. The moth must be ruthlessly destroyed. As it is, this isolated sanction to irrigation on these large canals leads to very uneven distribution of national wealth. Owners of lands under these canals get values of their lands increased by 100 to 500 per cent. without any effort and at the cost of the remaining owners of lands in the Province. Nor do these works give a commensurate direct or indirect benefit to the remaining lands which are not protected by canals and for whom Government have not been able to do anything, though these remaining 25 million acres are badly in need of irrigation facilities. In fact these irrigated areas have got to be supported from the ordinary revenues of the Province to make up the shortage between interest charges and the actual return.

The case of up-country small and large tanks is similar to that of large canals; only worse! The unearned profits by owners of land are in this case, smaller than those under ghatfed canals.

What Government can do for the remaining lands where canals with flow irrigation are not possible is to provide them with wells. Wells have in the past been constructed by owners of lands and not by Government but there is no reason why the State should not construct them in future. Unless Government do so, the increase required in this type of work which is not going to be remunerative will be limited and we will not be able to provide food to the next generation. The only practical method for making up the deficit in the interest charges on the capital invested on the construction of these wells is to make it up by the profits expected by our "Gold-mines," *viz.*, the ghatfed tanks.

Due to the peculiar geological formations in the Deccan traps, the question of locating wells has become very difficult and due to the uncertainty involved, poor cultivators cannot risk such a venture. Government must, therefore, either construct wells at Government capital or alternatively should give to the cultivator insurance against failure.

Such an insurance is quite possible provided the question of underground supplies of water and the distribution of porous and hard rocks of Deccan and their properties are taken up for study by the State. Individual efforts fall far too short of the requirements as the means of individuals are limited. The necessity of the study of this science being taken up by the State cannot therefore be stressed too strongly.

It will thus be seen that Bombay must spend Rs 160 crores on irrigation works and India about 1,500 to 2,000 crores to provide food to its population 30 years hence.

ROAD PROGRAMME FOR NIGERIA

Linking up with All-Africa Highway.

ONE of the most important schemes in a general comprehensive plan of development for Nigeria is for the extension of internal road communications, and a free grant of £1,810,000 has been made under the Colonial Development and Welfare Act, 1940, for the purpose. The scheme provides for the ultimate development of 48,275 miles of road.

It is regarded as essential that proper communication should be available for the development of Nigeria's internal trade and to provide adequate connections through Nigeria with the All-Africa Highway system running from the Cape, through the French Cameroons to Algiers, and also westwards towards Dahomey to the Gold Coast and other West African territories. Apart from the obvious advantages of the development of road communications, there is the important point that a proper road development programme will bring with it a considerable increase in the use of motor vehicles, and a large amount of revenue will accrue directly from the duties payable on the increased petrol used and on motor vehicle licenses.

After full consideration of Nigeria's requirements, a policy has been defined covering three classes of roads. The first of these is a grid of Trunk Roads "A", representing the main arterial road system of the territory. It consists of two principal North and South roads, the one running from Lagos to Kano on the West, and the other from Port Harcourt to Potiskum and Nguru on the East. These are crossed by a series of four roads running East and West at fairly regular intervals.

The second category, the "B" Trunk Roads are defined as those secondary trunk roads connecting provincial capitals and other large towns with the Trunk Road "A" system, or with one another, or with a port or convenient station on the railway.

The third category represents feeder roads, mostly of a less substantial nature, which provides the necessary local communications, with the Provinces, and the feeder system to the Trunk Roads "A" and "B" as well as to the railway and to the waterways.

The present scheme was originally prepared on the basis of a ten-year development, but it has subsequently been decided that it will not be possible to complete the programme until 1958-9. The total cost is estimated to be £9,000,00, and it is hoped in due course to secure agreement in principle that £4,370,000 should be provided under the Colonial Development and Welfare Act while Nigeria itself would contribute approximately £4,600,000.—(*"Roads and Road Construction."*)

* * *

"DEVELOP CONCRETE OF UNUSUAL STRENGTH."

Research studies at the Northwestern University, Technological Institute, have resulted in the development of a light-weight concrete of great strength which has been designed as a substitute for steel. Prof. George A. Maney, chairman of the Department of Civil Engineering, who has headed this work, reports that concrete columns can be produced at about one-third the cost of steel. Maurice Legaard, assistant professor, conducted the tests and designed a proposed plant for mass production.

The unit, designed for buildings, bridges, and special foundations, is composed of highly compressed concrete with spiral steel reinforcement. Exceptional strength was obtained by compressing the concrete and reducing the amount of water in the mix. Only one gallon of water per sack of cement was used. A special method of vibrating concrete is used. Columns of this reinforced concrete have been tested to 1,000,000 p s f. compression.—(*Rock Products*)

* * *

SOIL-CEMENT FOR ROAD MAINTENANCE.

A total of about 1,500 sq. yd. of pavement has been replaced in Virginia, U S.A., by addition of soil-cement patches, the size of patches varying from 2 by 3 ft. to about 11 by 15 ft. Some of the patches have now been in use under heavy traffic for over eighteen months. With a few exceptions, they are proving satisfactory.

At present, further repair work of this nature is planned by the Virginia department for other roadways showing similar destruction. On small patch work the procedure described will be used. Where long stretches have to be torn up, mixed-in-place construction will be followed.—(*"Constructional Review."*)

REINFORCED CONCRETE COLUMN DESIGN

By W. SCOTT-WILSON

A CUBE of plain 1-2-4 concrete will carry approximately a total load of 1 ton per square inch at the age of 4 weeks whence it follows that the safe load on a 12 in. cube of concrete, with a safety factor of 4, will be approximately 12 in by 12 in by ¼, or 36 tons If now we maintain the area 144 sq. inches but extend the length of the column indefinitely we shall find that the carrying capacity diminishes according to the ratio length of column/diameter of column, or l/d It is stipulated that a minimum area of longitudinal steel—0.8 per cent.—enables us to use the full safe stress for all values of l/d up to 15 and columns in this category are termed "short" Columns in which the ratio l/d exceeds 15 are termed "long" and the safe stress diminishes until the value $l/d = 40$ is reached, when the columns cease to have any practical value.

Columns of the square and rectangular types predominate in all classes of reinforced concrete work, and the amount of longitudinal steel employed varies between 1 per cent. and 5 per cent The longitudinal steel, varying in diameter from ½ in. to 1½ in should be arranged around the perimeter of the column and tied at intervals by steel binders whose chief function is to prevent the bars buckling outwards under load and causing the concrete cover to spall off. The longitudinal steel carries a proportion of the load, but since the stress in the steel is limited by adhesion to 15 times the stress in the surrounding concrete, say 600 by 15 = 9,000 lb per sq. inch, high percentages of steel are uneconomical and should only be used when the column section must be reduced to a minimum The carrying capacity of concrete columns can also be increased by using a richer concrete mix thereby increasing the safe stresses in concrete mix thereby increasing the safe stresses in concrete and steel.

"Short" Columns Under Concentric Loads

Let A_c = area of concrete section $b \times d$

A_s = area of longitudinal steel

p = steel percentage = $100\ A_s/A_c$

c = safe concrete stress in compression

m = modular ratio = 15

W = total safe load

then $W = c\,(A_c - A_s) + A_s \times mc$

but since $A_s = p \times A_c/100$

$$W = A_c\left\{1 + \frac{(m-1)}{100}p\right\}c \quad (1)$$

or $W = A_c \times k$ for a given concrete stress c

thus if $A_c = 144$ sq. in., $C = 700$ lbs. per sq in. and $p = 2\%$

then from e.g. (1)

$W = 144 \times 1.28 \times 700/2240 = 58$ tons

or $58 = 144 \times k$

from which

$k = 58/144 = 0.4$

corresponding with the c = 700 curve, Fig. 1, which gives values of k for various concrete stresses c.

Example 1.

Determine from Fig 1 the safe concentric load on a column 14 in. by 14 in. in section reinforced with 3 per cent

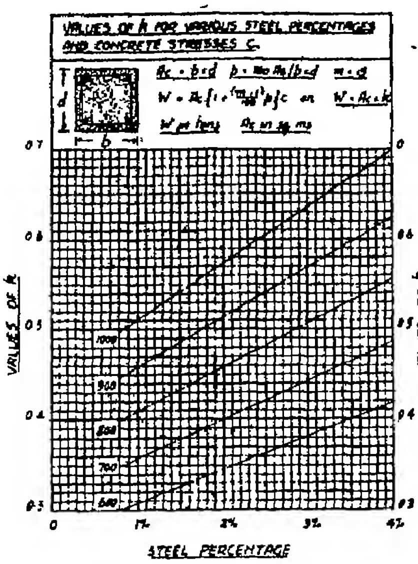


Fig. 1. Safe concentric load calculation graph

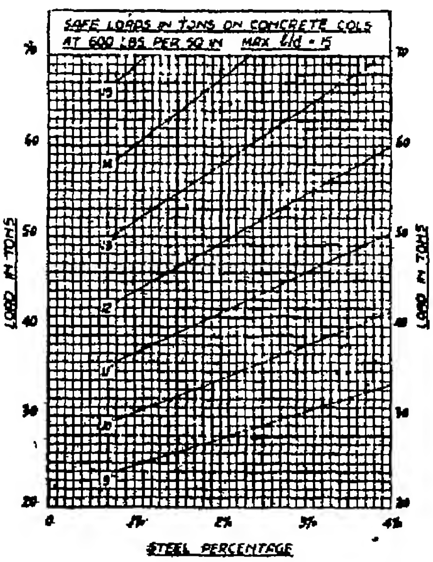


Fig. 2. Curve for calculating size of column and steel percentage required

longitudinal steel if the safe concrete stress c in 900 lb. per sq inch

For these conditions the value of k from Fig 1 is 0.57

and safe load

$W = 14 \times 14 \times 0.57 = 111.7$ tons

checking from e g (1)

safe load

$W = 196 \times 1.42 \times 900/2240 = 111.8$ tons

Curves of the type shown on Figs 2 and 3 are useful inasmuch as they show at a glance the size of column and steel percentage required to sustain a given load based on a safe concrete stress of 600 lb. per sq inch

Thus, for a load of 100 tons the sections available are :—

18 in. by 18 in with 1.1 p.c reinforcement.

17 in. by 17 in. with 2.07 p.c. reinforcement

16 in by 16 in with 3.24 p.c reinforcement

If now the safe stress is increased to 800 lb. per sq in. the above columns will carry ·

$100 \times 800/600 = 133.3$ tons

so that these curves may be used for any desired stress by multiplying the load in tons by the ratio of stresses, or ·

load capacity = load in tons × actual stress/600

In regard to the diameter and spacing of binders these may be

¼ in. diam. at 6 in crs for columns up to 12 in × 12 in

$\frac{5}{16}$ in. diam. at 9 in. crs for columns between 12 in. × 12 in. and 18 in. × 18 in.

⅜ in diam at 12 in. crs for columns between 18 in. × 18 in and 24 in. × 24 in when the area of steel As is around 2 per cent.

"Long" Columns Under Concentric Loads

When the ratio l/d exceeds 15 the stress is reduced proportionately as shown on Fig. 4 until the value $l/d = 40$ is reached when the safe stress is 100 lb. per sq inch This conforms with the regulations which state that maximum $l/r = 120$ in which r is the least radius of gyration of column

since $r = \sqrt{I/A} = \sqrt{d^2/12}$ for square columns $= 0.3d$

then $l/0.3d = 120$ and $l/d = 36$.

Hence, to find the safe load for a "long" column multiply the safe load for a "short" column of similar dimensions by the ratio $\frac{\text{reduced stress}}{600}$ From Fig 2 a "short" column 14 in. × 14 in. with 1 per cent. reinforcement carries 60 tons at 600 lb per sq. inch for any length up to $15 \times 14/12 = 17$ ft. 6 in. If now the column length is increased to 29 feet,

ratio $l/d = 29 \times 12/14 = 25$

and from Fig 4 the reduced safe stress is 400 lb per sq in. Hence, safe load $W = 60 \times 400/600 = 40$ tons

It is important to recollect that the foregoing methods apply only to columns carrying truly concentric loads—a condition seldom realised in practice

Eccentrically Loaded Columns

Consider the "section showing distortion in framed structure" indicated on

Fig 5. At the left side, termed monolithic construction, the joints between beams and columns are rigid and at the right side, termed non-monolithic construction, the joints between beams and columns are non-rigid or hinged. Rigid joints result when the top tension steel from the beam runs into and is properly anchored in the column, see Fig. 5 (a), so that the beam cannot bend under load without turning the columns above and below the beam through the same angle. In such cases the load on the column is eccentric and this results in a non-uniform stress variation across the section in which tension may be present Non-rigid or hinged joints result when the top tension steel in the beam—Fig 5 (a)—is omitted so that the beam is, more or less, free to rotate without turning the columns above and below the beam through the same angle. In such cases the load on the column is still eccentric because when the beam deflects under load the ends do not remain horizontal and the centre of pressure or bearing does not coincide with the centroid of the column area. Obviously, the external columns in framed structures are more susceptible to eccentric loading than internal columns—see Fig 5 (b), and it is necessary to investigate briefly the effect of such loading.

Consider a case in which the external columns are very stiff compared with the beams framing into them, then the moment in the beam where it enters the column will approximate to—$wxl^2/12$.

Consider now a case in which the external columns are very slender compared with the beams framing into them, then the moment in the beam where it enters the columns will approximate to zero.

All practical cases lie somewhere between these limits.

To get an idea of the average case assume that T beams of 24 feet span carry a total load of 48 tons and frame into external columns 14 feet high The thickness of floor slab is 5 in and the breadth of slab in compression is 70 in. If the lower columns are 16 in by 16 in in section and the upper columns 14 in. by 14 in in section, determine the approximate moments around the junction

Upper columns 14" × 14" I = 3940 ins^4 stiffness Su = Inertia Col./length of Col

$$=3940/14 \times 12 = 23\ 4$$

Lower columns 16" × 16". I = 7090 ins^4 stiffness Sl = Inertia Col /length of Col.

$$= 7090/14 \times 12 = 42\ 2$$

T beams I = 53,600 ins^4
stiffness Sb = Inertia beam/span of beam = 53,600/24 × 12 = 186

moment factor

$$= \frac{Sl + Su}{Sl + Su + Sb}$$

$$= \frac{42.2 + 23.4}{42\ 2 + 23\ 4 + 186} = 0.26$$

negative moment in beam at junction with column.—

$$-Mb = 0.26 \times w \times l^2/12$$
$$= wl^2/46$$

moment at base of upper column :—

$$Mu = \frac{Su}{Sl + Su + Sb}$$

$$= \frac{23\cdot 4}{251\ 6} = 0\cdot 09\ wl^2/12$$

$$= wl^2/133$$

moment at top of lower column .—

$$Ml = \frac{Sl}{Sl + Su + Sb}$$

$$= \frac{42\ 2}{251\cdot 6} = 0.17\ wl^2/12$$

$$= wl^2/70$$

from which Mu + Ml — Mb = zero

Consider the upper 14" × 14" columns :—
total load from beam
$= 24 \times 2240 = 54{,}000$ lbs.
moment at base of column
$= 54{,}000 \times 24 \times 12/133$
$= 117{,}000$ in. lbs.

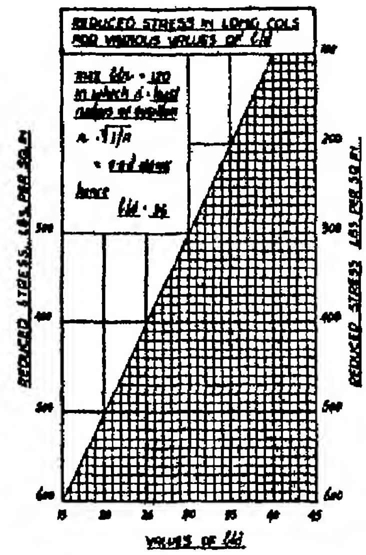


Fig. 3. Curve for calculating size of column and steel percentage required

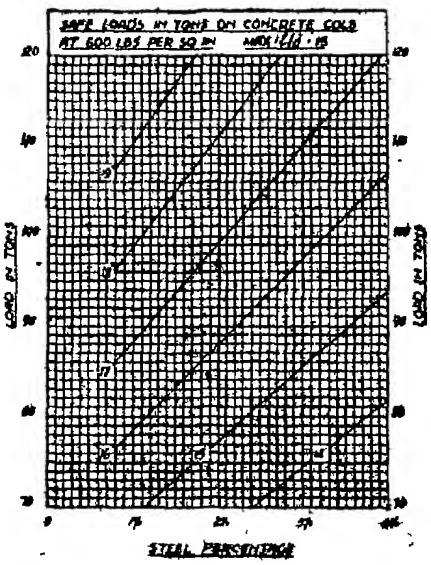


Fig. 4. Curve where ratio l-d exceeds 15

stress due to bending

$$= \pm \frac{117{,}000 \times 14}{2 = 3940}$$

$= \pm 208$ lbs. per sq. in.

stress due to direct load (2 floors)
$= 54{,}000 \times 2/230$
$= 470$ lbs. per sq. in.

Hence, maximum skin stress
$= 470 + 208 = 678$ lbs per sq in.
and minimum skin stress
$= 470 - 208 = 262$ lbs. per sq. in.
average stress across section
$= \frac{1}{2}(678 + 262)$
$= 470$ lbs. per sq. in.

Hence, 14" × 14" columns reinforced with 4 bars $\frac{3}{4}$" diam. and $\frac{1}{4}$" diam. binders at 6" crs are suitable.

Consider the lower 16" × 16" columns :—
total load from beam
$= 24 \times 2240 = 54{,}000$ lbs.
moment at top of column
$54{,}000 \times 24 \times 12/70$
$= 220{,}000$ in. lbs.

stress due to bending

$$= \pm \frac{222{,}000 \times 16}{2 \times 7090}$$

$= \pm 250$ lbs. per sq in.

stress due to direct load (3 floors)
$= 54{,}000 \times 3/300$
$= 540$ lbs. per. sq in.

Hence, maximum skin stress
$= 540 + 250 = 790$ lbs. per sq. in
and minimum skin stress
$= 540 - 250 = 290$ lbs per sq in.
average stress across section
$= \frac{1}{2}(790 + 290)$
$= 540$ lbs per sq in

Hence, 16" × 16" columns reinforced with 4 bars 1" diam and $\frac{1}{4}$" diam binders at 6" crs are suitable.

NOTE .—The foregoing calculations are typical where bending is taken into account in which case the safe skin stress is 750 lbs. per sq in

Alternative Method

Suppose now we had neglected bending, or the effect of eccentric loading, and designed the columns for concentric loading, then .—

Direct load on upper columns (2 floors) = 24 × 2 = 48 tons, and from Fig 2, 12 in. × 12 in. columns with 1.8 per cent reinforcement (4 bars $\frac{7}{8}$ in diam.) are suitable.

Direct load on lower columns (3 floors) = 24 × 3 = 72 tons, and from Fig 3, 14 in. × 14 in columns with 2 7 per cent. reinforcement (4 bars $1\frac{1}{8}$ in. diam.) are suitable.

The maximum stresses in each case being 600 lbs. per sq in

Applying now the bending theory to these columns we have :—

Upper columns 12" × 12". I = 2135 ins.^{4} stiffness Su = Inertia Col./length of Col.

$$= 2135/14 \times 12 = 12.7$$

Lower columns 14" × 14". I = 3940 ins.^{4} stiffness Sl = Inertia Col./length of Col.

$$= 3940/14 \times 12 = 23.4$$

T beams. I = 53,600 ins.^{4}
stiffness Sb = Inertia beam/ span of beam = 53,600/24 × 12 = 186
moment factor

$$= \frac{Sl + Su}{Sl + Su + Sb}$$

$$= \frac{23.4 + 12.7}{23.4 + 12.7 + 186} = 0.162$$

negative moment in beam at junction with column :—

$$-M_b = 0.162\ wl^2/12 = wl^2/74$$

moment at base of upper column :—

$$M_u = \frac{S_u}{S_l + S_u + S_b}$$

$$= \frac{12.7}{222.1} = 0.057\ wl^2/12$$

$$= wl^2/210$$

moment at top of lower column :—

$$M_l = \frac{S_l}{S_l + S_u + S_b}$$

$$= \frac{23.4}{222.1} = 0.105\ wl^2/12$$

$$= wl^2/114$$

from which $M_u + M_l - M_b = $ zero.

Consider the upper 12″ × 12″ columns :—

total load from beam
$= 24 \times 2240 = 54{,}000$ lbs.

moment at base of column
$= 54{,}000 \times 24 \times 12/210$
$= 74{,}000$ in. lbs.

stress due to bending

$$= \pm \frac{74{,}000 \times 12}{2 \times 2135}$$

$= \pm 208$ lbs. per sq. in

stress due to direct load (2 floors)
$= 600$ lbs. per sq. in.

Hence, maximum skin stress
$= 600 + 208 = 808$ lbs. per sq in

and minimum skin stress
$= 600 - 208 = 392$ lbs per sq. in.

average stress across section
$= \frac{1}{2}(808 + 392)$
$= 600$ lbs. per sq. in.

Increase in stress due to bending 33%

Consider the lower 14″ × 14″ columns :—

total load from beam
$= 24 \times 2240 = 54{,}000$ lbs.

moment at top of column
$= 54{,}000 \times 24 \times 12/114$
$= 136{,}400$ in. lbs.

stress due to bending

$$= \pm \frac{136{,}400 \times 14}{2 \times 3940}$$

$= \pm 242$ lbs. per sq. in.

stress due to direct load (3 floors)
$= 600$ lbs. per sq. in.

Hence, maximum skinstress
$= 600 \times 242 = 842$ lbs per sq. in.

and minimum skin stress
$= 600 - 242 = 358$ lbs per sq in

average stress across section
$= \frac{1}{2}(842 + 358)$
$= 600$ lbs. per sq. in.

Increase in stress due to bending 40%.

When bending is taken into account, however, the safe skin stress is 750 lbs. per sq in and although we exceed this limit by 6 7 per cent. in the case of the 12 in. by 12 in. columns and 12 per cent. in the case of the 14 in. × 14 in. columns, there is no doubt that these columns are perfectly safe. It must also be remembered that the maximum skin stresses occur only at each end of the column and diminish to a uniform stress of 600 lbs. per sq. in where the moment is zero.

The two methods of calculation indicated are both in use but it is desirable that bending be taken into account, particularly in external columns, since the loading on the columns is eccentric whether the joints are rigid or non-rigid.—(*With acknowledgments to "Civil Engineering."*)

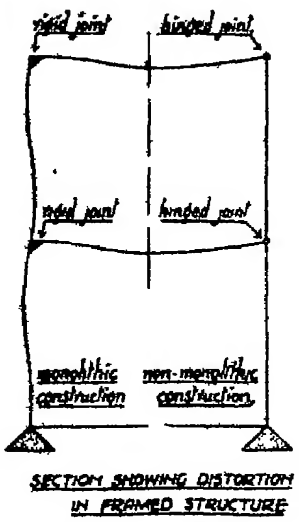


Fig. 5a. Showing distortion.

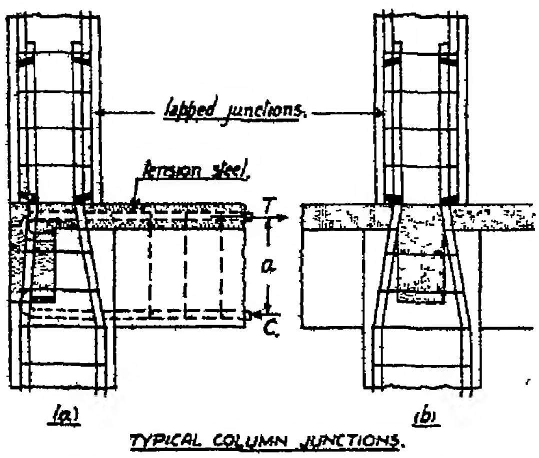


Fig. 5b. External columns and eccentric loading.

Built in pre-fabricated concrete erected on the site, this grain drier is now under construction at Burgham Farm, Felton, Northumberland. It is 72 ft. long by 27 ft. wide and 27 ft. 9 ins. high (22 ft. to eaves). A 12 ft. wide lean-to, also in concrete, extends the full length of the building. The eight silos (two for storage before and six for after drying), are constructed of interlocking staves supportd by bonds. The drying capacity is estimated at three tons per hour.—("*Farmers' Weekly*" *London.*)

NEW CHART FOR THE DESIGN OF REINFORCED CONCRETE AND HOLLOW TILE FLOORS AND SLABS

By L. J. EICHELGRUN

THE chart (opposite page) can be used to compute the bending moments and simultaneously to dimension the slab with regard to thickness, reinforcement and shear stressing.

The upper half records the span for different conditions of continuity

$$\left(\frac{wl}{8}, \frac{wl}{10}, \frac{wl}{12} \ \& \ \frac{wl}{16}\right)$$

and gives curves for uniform distributed load varying from 60 up to 400 lb./sq. ft. The bending moments will be read on the middle, horizontal division line.

The lower half of the chart records the bending moments, the effective thickness of the slab, the limiting values for a concrete stress of 750 and 850 lb./sq. in. and the steel reinforcement. The latter is given in sq. in. and alternatively round steel bars at various spacing or 2 No. bars per rib of a hollow tile floor. In a separate table the allowable shear forces are given if no shear provision is needed.

The chart is calculated for m = 15, in accordance with the present-day L.C.C. regulations; also the post-war proposed Code of Practice is based on this value. The steel stress is 18,000 lb./sq. in., the concrete stresses are 750 and 850 lb./sq. in.

If the bending moment shall be found by this chart, the reading starts on the left hand top ordinate; the reading proceeds thus: span — load — bending moment — thickness of slab — reinforcement. For other than uniform load the bending moment has to be computed separately and the reading of the chart starts from the bending moment on the middle line. The use of the chart is best explained by the following example, which is registered on the chart.

Total load = 200 lb./sq. ft.
Allowable concrete stress 750 lb./sq. in.

Example: *Span* = 15 ft., condition of continuity $\frac{wl}{10}$

1. Start reading from left hand top vertical for $\left(\frac{wl}{10}\right)$ and proceed horizontally till 200 lb. load curve is reached, go vertically down and read the bending moment = 54,000 lb. in.

2. From the bending moment go vertically down till 750 lb./sq. in. curve is reached. Read from the straight lines, representing the thickness of the slab, minimum effective thickness of slab = 6 in. Go horizontally to the left to read the reinforcement.

3. Assume thickness of slab was decided to be 7 in. In this case do not go down to the curve, but stop where the vertical line cuts the line for slab thickness of 7 in. One goes horizontally to the left and reads steel reinforcement required = .50 sq. in.

4. One reads simultaneously the following steel reinforcement: ⅞ in. dia. at 12 in. cc. or ¾ in. dia. at 9 in. cc. or ⅝ in. dia. at 6 in. cc. or ½ in. dia. at 4 in. cc. The standard hollow tile floor slab would require ⅝ in. dia. bars, 2 No. bars per rib.

5. From the table at the bottom of the chart one reads the allowable shear forces: for the R.C. slab of 7 in. thickness 5,480 lb., and for the hollow tile slab 1,095 lb.

The actual shear force has to be computed:

$$\frac{200 \times 15}{2} = 1500 \text{ lb}$$

Result: R.C. slab does not need shear provision, the hollow tile slab requires shear provision such as bent-up bars or stirrups, or replacing every second tile by full concrete.—(*With acknowledgments to "Civil Engineering."*)

REINFORCED CONCRETE PIPES 8-FT. IN DIAMETER

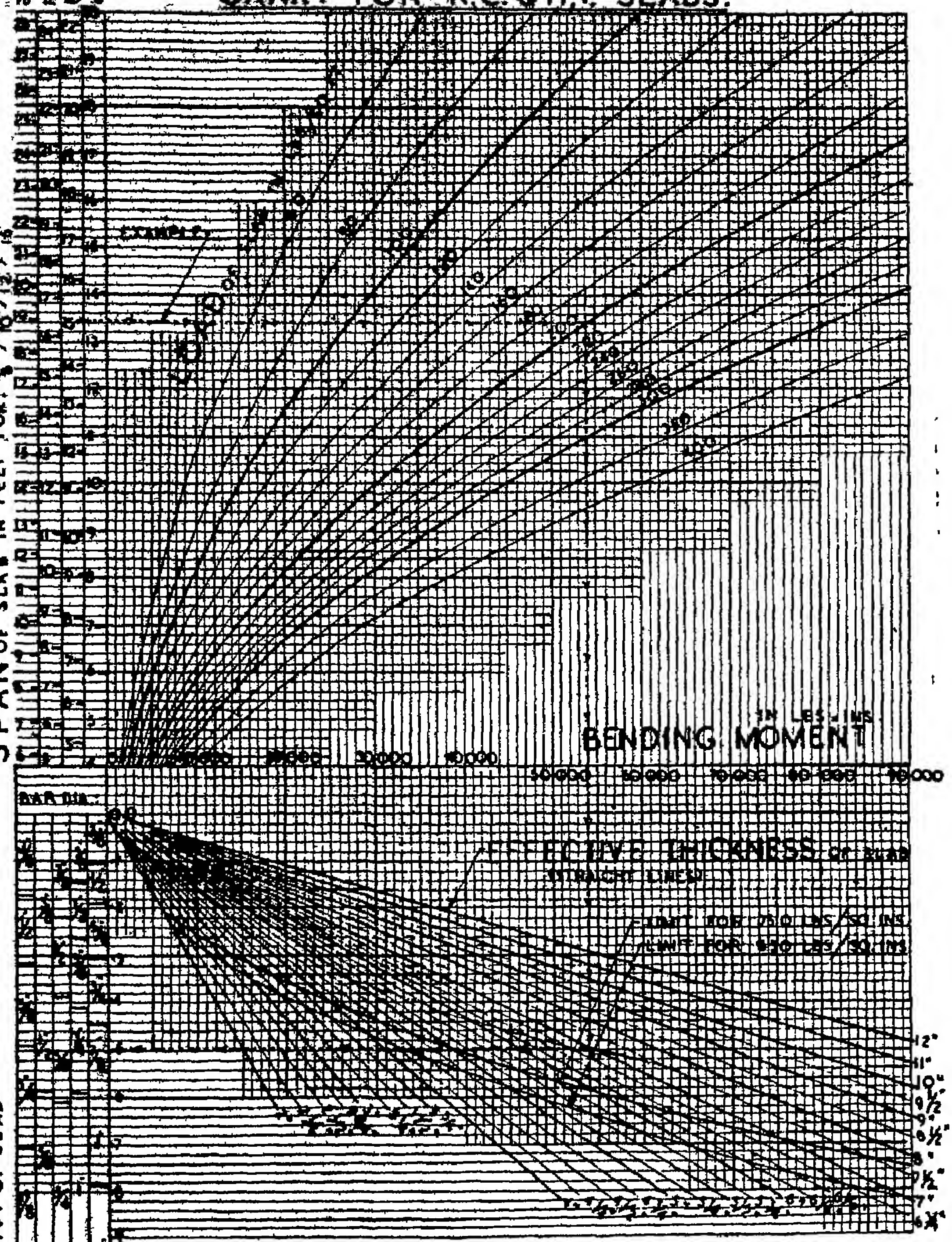
ABOUT 5,000 ft. of reinforced concrete pipeline of 96 in. internal diameter has been laid for the water-circulating tunnels of the Los Angeles (California) Department of Water and Power. The pipes were cast in lengths of 12 ft., and each section weighs 21 tons. The reinforcement comprises two concentric cages of $\frac{11}{16}$-in. and ⅞-in. bars, welded at the crossings of the horizontal bars and the spirals. *Fig.* 1 shows the winding of the spiral reinforcement. In the case of welds for transverse reinforcement, each weld was specified to resist a stress of 40,000 lb. per square inch of bar.

The pipes were cast by standard methods; that is, the reinforcement cages were lowered over a collapsible inner mould and the outer mould then lowered into place. The moulds and reinforcement cages were handled by crane. The proportions of the concrete were 1 : 2 : 3, using ¾-in. coarse aggregate. Internal and external vibrators were used, and both steam and water curing were adopted.—"*Concrete Building & Concrete Products.*")

Fig. 1.—Winding Reinforcement.

Fig. 2.—Transporting 8-ft. Pipes.

CHART FOR R.C. & H.T. SLABS.



ALLOWABLE SHEAR IN LBS (WITHOUT SHEAR PROVISION)

THICKNESS OF SLAB		2"	2¼"	2½"	2¾"	3"	3¼"	3½"	3¾"	4"	4¼"	4½"	4¾"	5"	5¼"	5½"	5¾"	6"	6¼"	6½"	6¾"	7"	7½"	8"	8½"	9"	9½"	10"	11"	12"
R.C. SLAB SHEAR STRESS	75	1565	1760	1960	2155	2350	2545	2740	2935	3130	3330	3525	3720	3915	4110	4305	4505	4700	4895	5090	5285	5480	5875	6265	6655	7045	7440	7850	8615	9395
	85	1750	1975	2190	2410	2630	2850	3070	3290	3510	3730	3945	4165	4385	4505	4725	4945	5265	5485	5705	5925	6140	6580	7020	7455	7895	8335	8770	9450	10525
H.T. SLAB SHEAR STRESS	75	310	350	390	430	470	510	550	585	625	665	705	745	780	820	860	900	940	980	1020	1055	1095	1175	1255	1330	1410	1490	1565	1625	1880
	85	350	395	440	480	525	570	615	660	700	745	790	835	880	920	965	1010	1055	1095	1140	1185	1230	1315	1405	1490	1580	1665	1755	1940	2105

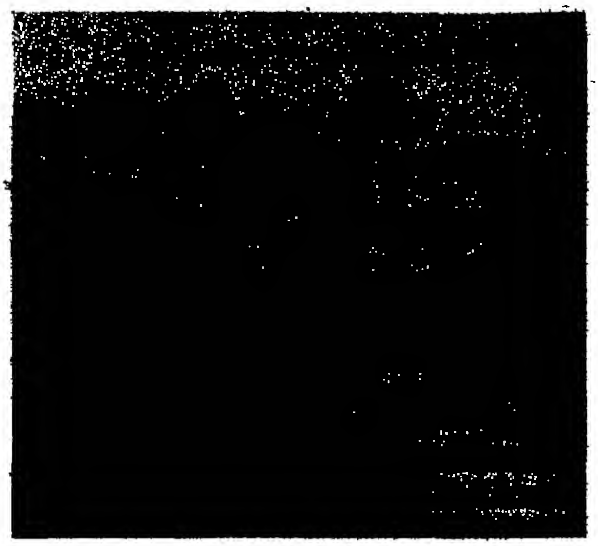
NOTES: m = 15 WIDTH OF SLAB = 1'-0"

H.T. SLAB: WIDTH OF TILES: 12", RIB: 3". L.J.E.

WARTIME ACCESS HIGHWAY HAS POST-WAR VALUE

By HAL G. SOURS, Assoc. M.Am.Soc. C.E., Director, Ohio State Department of Highways, Columbus, Ohio.

Completed Highway Serving the Aircraft Plant—Twin traffic lanes are designed for a speed of 70 miles an hour.



Overpass Separates Railway and Highway Traffic—Falsework was so set up that rail traffic could be maintained.

Vast expansion of the Goodyear Aircraft Plant near Akron Ohio, created urgent need for adequate highway traffic lanes in the vicinity of the company's grounds. The Ohio Department of Highways and the Public Roads Administration co-operated in developing the project. Plans were carefully prepared so that the traffic artery, in addition to serving a wartime need, will later become part of a permanent belt highway bypassing Akron on the south-east. As reported by Mr. Sours, over 70% of the employees use private cars in travelling to their work at the plant

A FORECAST made in 1940 indicated a 325% increase in employment at the Goodyear Aircraft Corporation plant near Akron, Ohio, and thus showed the necessity for increased capacity and more fluid movement of traffic on state route U.S. 224 and connecting roads in the vicinity of this defense industry from Pearl Harbour came the spark that was to change this secondary high-maintenance cost highway into one of the typical new access routes constructed throughout the nation. A joint co-operative agreement was entered into promptly between the Ohio Department of Highways and the Public Roads Administration and a contract was awarded in May 1942 for 1.79 miles of four-lane divided highway. The estimated traffic justified a four-lane divided type Traffic counts soon after the road was opened showed 9,328 vehicles per 24-hour day, and 1,214 vehicles in a peak hour This will quite probably increase.

Post-war Usefulness Assured

Future usefulness of this improved highway is assured, as after the war it will become a permanent link in a belt-line route around southeastern Akron and also the first link in a major east-and-west highway across the state. The relation of new construction to the old state route U.S. 224 is shown in Fig. 1.

The design provided for two 24-ft concrete pavements of typical section, separated by a paved medial divider 4-ft wide which merges into a 30-ft. seeded medial divider near the east end of the project. From the 4-in. sand-stone curb, the shoulder slopes ¾ in. per ft. to the right-of-way line. The major approach ramp from state route U S. 224 at the entrance to the plant consisted of two 12-ft. lanes separated from a single 12-ft. lane by a 2-ft. asphaltic medial divider. Construction of the approach ramp included one continuous concrete-beam bridge to separate the traffic, on this ramp from through traffic Fortunately the old route served admirably during the construction of this bridge and of the new highway and outside of physical hazzards such as curves and poor condition of the road surface, there was little inconvenience to defense workers in their movements to and from work. While as much speed in construction was maintained as was practicable, haste was not so urgent as in some other parts of the country, where no roads were available to serve new plants

Before the new highway was designed surveys of traffic volume and direction were made by the Division of Traffic and Safety of the Ohio Department of Highways (Fig 2). The anticipated major conflicting movement for a one-half hour volume, where the flows of 180 and 194 vehicles intersected the 324 stream of traffic, did not cause any appreciable delay, since the 324 vehicles cleared the intersection ahead of the incoming traffic.

A Safe Speed of Seventy Miles an Hour

Two entrance lanes and one exit lane on the approach ramp were designed for a lane capacity of 750 vehicles and a safe speed of 35 miles an hour. State route U.S. 224 was designed for a maximum hourly lane capacity of 1,000 vehicles at a safe speed of 70 miles an hour and a 1,000-ft. sight distance. Maximum curvature is 2° 30', with return radii for service and access roads to the plant ranging from 35 to 100 ft.

Traffic induced by increased employment has exceeded original estimates. The industry has provided ample parking lots, well distributed in the different plant areas. Expected car use by employees was estimated in 1941 at 2·5 persons per car. A field count completed in April 1943 gave an actual use of 2·6 persons per car entering and leaving. This compares favourably with the state average of 2·13 persons per car.

Primary intersections with South Arlington Street, the Roadside Park approach, and the ramp approach to service roads were channelized to fit estimated volume and direction of traffic flow. Median strips or islands in this channelization are of asphaltic concrete confined by a 4-in. sandstone curb. Islands are set back approximately 2 ft. from the projected curb line as protection from weaving vehicles. The present intersection with George Washington Boulevard is temporary and will be relocated and channelized when U. S. 224 is improved east of this intersection.

Very few employees walk or ride bicycles to reach the plant because of its remote location. Recent studies indicate that over 70% of the employees are dependent on private cars and the remainder use buses, which are crowded to capacity. Maintenance parts and the services of mechanics are increasingly difficult to obtain. Approximately 60% of the employees reside 5 miles or more from the plant.

Parking Congestion Eliminated

Personnel managers have reported that a major grievance at some industries is the delay of 30 minutes or more twice

a day in getting in or out of parking lots due to congestion. Because of these critical personnel and transportation factors, and the fact that there is little hope of securing additional transportation equipment, it is apparent that efficient access roads to parking lots and service roads providing safe and speedy transportation are a necessary and vital part of defence production to-day.

The construction of a project like the one under discussion does not present as many unusual features as might be expected. However, in this case the necessity of avoiding interruptions to traffic did call for study. The ordinary highway project, constructed while traffic goes on, involves traffic which to a large extent changes from day to day and thus can be readily shifted without confusion. It was not possible to move traffic about readily in this instance as the greater part was of a local nature interested in access to the plant. When drivers became familiar with one procedure it was difficult to get them to change it without causing some confusion. Relocation of the existing route along plant entrances, and leaving the old pavement in place to remain as a service road, simplified the problem to a certain extent

Like many other such plants, the Goodyear Aircraft Assembly Plant expanded rapidly during the earlier days of the war. As employment rose considerably over what was expected originally parking facilities required revision. These changing conditions called for several revisions in plant entrances to meet the demands of traffic The addition of a parking area east of Kelly Avenue and north of Waterloo Road made it necessary to pave a portion of the Waterloo Road approach during the winter of 1942-1943 so that traffic could be adequately served when maximum employment was reached. Pavement on this section, placed during late January and early February, required the removal of approximately 18 in of frozen subgrade and replacement before work could proceed As it was not originally planned to pave this section until the following spring the subgrade had not been covered

During construction of the new bridge, traffic was maintained on adjacent structure. Concrete sills in foreground were placed to support timber falsework.

Supplementary Road Revisions

Cement treated with Vinsol resin was used throughout the project in the pavement concrete to resist the action of salts used extensively in this area in the removal of snow and ice

Changing traffic requirements caused by expanding plant and parking facilities led to the improvement of three additional sections of highway to act as feeder routes to the project Arlington Street north from U S. 224 was the first of the additional access routes to be placed under contract This was followed recently by Kelly Avenue from the old U S. 224 to Triplett Boulevard, on which work is now completed. The Triplett Boulevard section from Arlington Street to Kelly Avenue, which has been advertised for bids, and the continuation of U S. 224 east from George Washington Boulevard to Route 8, which is now under contract, will complete the access roads in this general area.

Relocation of U S. 224 crossed a section of unstable peat and muck between Stas 203 and 204+72. The plans provided for removal before embankment construction was started. This procedure was used here because the peat was only about 5 ft. deep, while the fill section at this point was 35 ft high Fortunately rock from roadway excavation about 2,000 ft. away was available for replacement, so that a sufficient depth of material could be placed to provide a stable foundation.

Two Bridges Required

Relocation and separation of grades required the construction of two major bridges One of these, which carries traffic over the Baltimore and Ohio Railroad, has a 64-ft. clear span, a reinforced concrete rigid frame, and concrete "U" abutments It has two 26-ft. roadway sections, a 4-ft dividing strip, and two 6-ft. walks The rock-cut railroad section provides an ideal condition for this type of structure. Since it is on a 1° 30' horizontal curve, it has a superelevation of 1·57 ft Because of wartime restrictions on the use of steel, the contractor worked out a novel timber centering plan which proved satisfactory He constructed concrete sills on the edges of the rock cut with the top in the same plane as the curve superelevation. These sills were placed on 7·5-ft and 8 5-ft centres Falsework was then set up using 8-by-8 and 10-by-10 timbers on 5-ft centres for the north part of the deck, which was the low side of the superelevated curve The railroad track, which was in service during construction, was spanned with 12-by-12 timbers spaced 16 ft in the clear

Falsework was released on the north side as soon as the required period was ended, and pulled along the inclined concrete sills to the high side of the superelevated curve to permit construction of

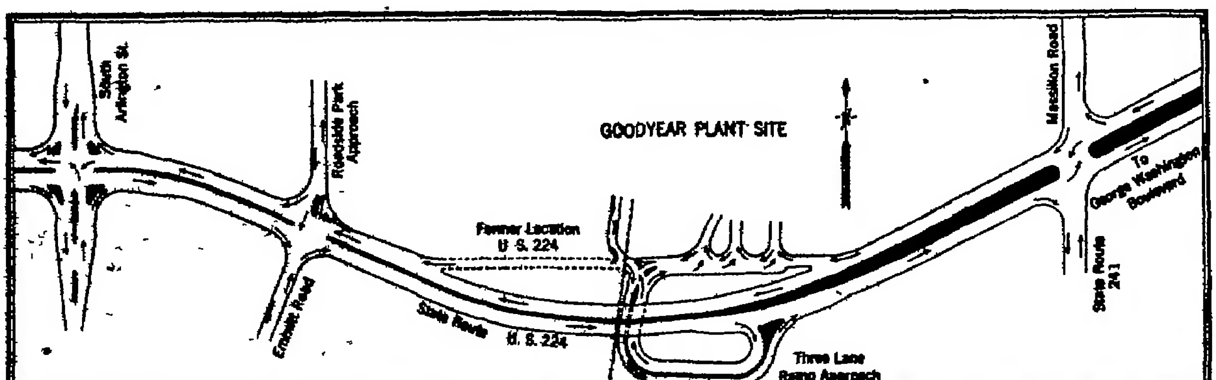


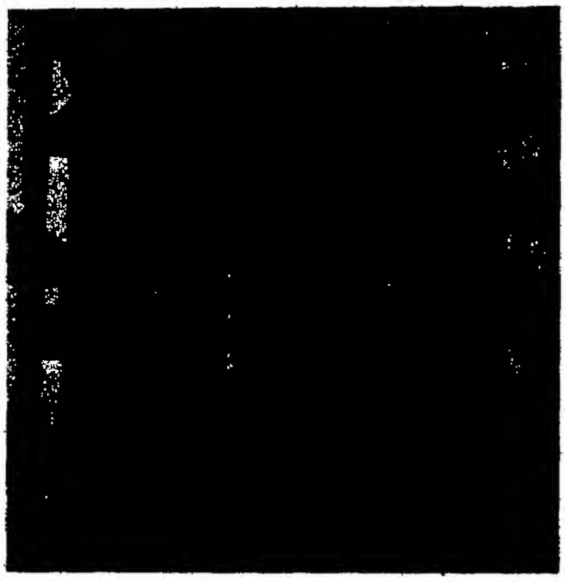
Fig. I. Access Highway for Goodyear Aircraft Plant.

the other deck section. This method permitted form work to be used again with a minimum of time loss between placement of adjoining deck sections, and also at a minimum cost for adapting the forms The procedure used was (1) to loosen the forms to secure clearance, (2) move the forms, (3) change the face forms to provide for coping, and (4) wedge up to grade

The other bridge constructed as a part of this project is a continuous concrete-beam type composed of four spans, consecutively 40½, 55½, 55½ and 40½ ft. from centre to centre of bearing Like the structure just described, it has two 26-ft. roadway sections with a 4-ft. dividing strip and two 6-ft. walks, and is on a 1° 30' curve. It carries traffic from U.S. 224 over the Goodyear industrial track and a ramp providing access and exit to the plant for the thousands of employees engaged in vital war work there. False-work was set up in such a way that railroad traffic could be maintained.

On the newly constructed project shoulders and slopes are seeded to provide a cover against erosion and to blend them into the landscape. This project is a good example of a very necessary wartime facility which also constitutes a desirable improvement in an important highway system.

Construction was supervised by the Ohio Department of Highways. H. G. Sours, director; W. H. Moore, division engineer; M. D. Shaffer, chief engineer, Bureau of Location and Right of Way; R. O Nelson, chief engineer of construction; W. S Hindman, chief engineer, Bureau of Bridges, H. E. Neal, chief engineer, Bureau of Traffic and Safety; W. M. Wardman, division construction engineer; and L. W Hine, project engineer. The contractor for the project was A. J. Baites Construction Company, Robert Craig, superintendent.—(*With acknowledgments to "Civil Engineering"*)



Forms used for bridge piers were readily set and removed wedge pins connect form braces, form liner was used.

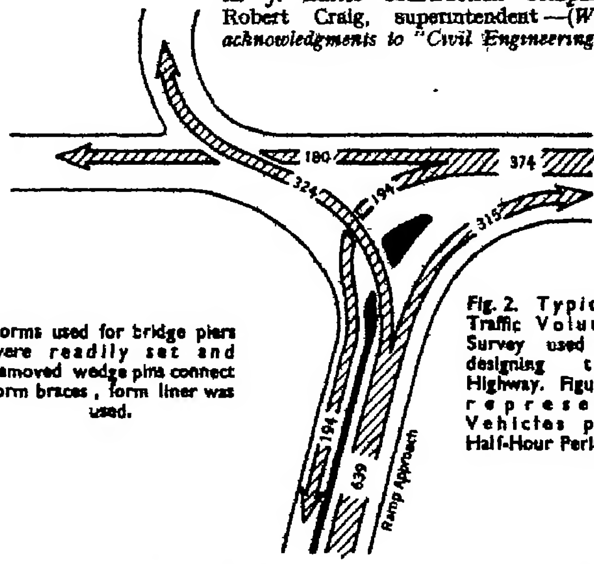
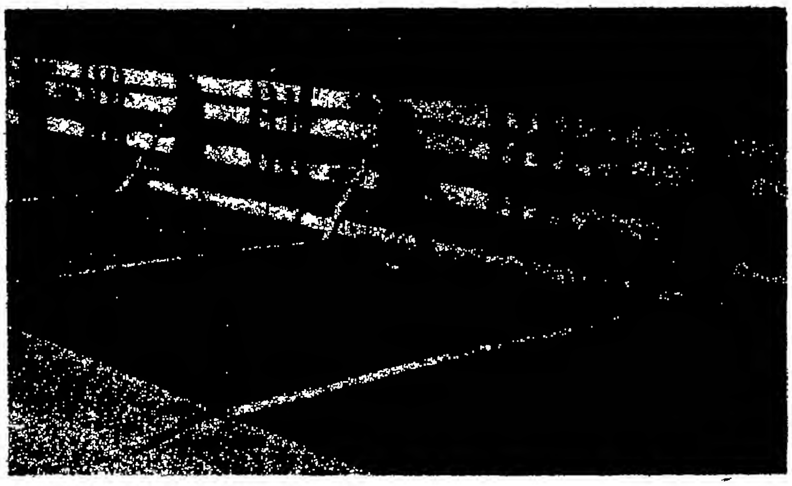
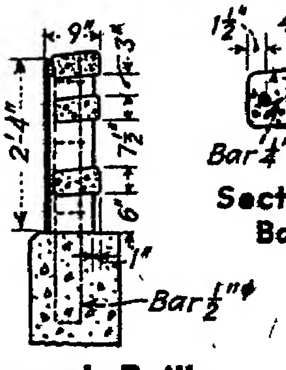
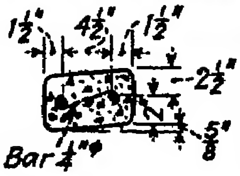


Fig. 2. Typical Traffic Volume Survey used in designing the Highway. Figures represent Vehicles per Half-Hour Period.





Concrete Railing



Section of Bar

WOODEN FORMS milled to exact shape of cast-in-place concrete railing are erected by Bryant & Detwiler, contractor, Detroit, on bridge to carry one of divided roadways of Detroit Industrial Expressway over Southfield Road. Cast-in-place railings are typical of all highway grade separation bridges constructed on this modern freeway by Michigan State Highway Department— (*"Construction Methods."*)

PUMPING OF CONCRETE SLABS

Methods for Prevention and Correction

(Recommendations of a Committee appointed by the Highways Research Board of America, and published No. 4 of a series of bulletins—Wartime Road Problems.)

THE pumping action of concrete slabs at joints, cracks and edges results from an unfavourable combination of soil type, water and amount of weight of traffic.

The sub-grade soil type, where pumping occurs, consists of soils containing a predominance of silt and clay. Non-plastic granular soils such as sands and gravels are not susceptible to this action.

Free water must be present immediately under the joint, crack or edge of the pavement for pumping to occur. As a result, this action takes place during periods of prolonged rainfall such as may be expected normally in the spring and fall seasons. The source of free water is largely surface infiltration through cracks, joints and edges of the pavement, but may be from water-bearing strata or high water-tables.

A large number of heavily loaded trucks, in combination with a susceptible soil type and water, is the final and most important factor in pumping. The deflection of a slab end is dependent upon the total load passing over a joint or crack at any given time. Thus, the load which governs the amount of the deflection is the axle load regardless of the number and size of the tyres carrying the load. The present war effort has resulted in an increase in the number of heavily loaded vehicles, which in turn has increased both the severity of the pumping action and the extent of its occurrence.

Preventive and Corrective Procedures

The problem of maintenance in relation to pumping occurs in connection with two conditions:

Case 1.—Pavements on which pumping may occur, due to the character of the sub-grade and expected heavy loads.

Case 2.—Pavements on which pumping has progressed to an appreciable degree, due to the character of the sub-grade and the presence of heavy loads.

Prevention

In case 1 an examination should be made of the sub-grade on any section of pavement which is being subjected to a greater than normal number of heavy loads. Such an examination should be made by an experienced soils engineer and all the soils on the section should be classified by visual inspection or by the testing of such samples as may be deemed necessary. Since examination of many pavements has indicated that pumping does not occur on sub-grades composed of pervious sandy soils or gravels, special maintenance in areas having such subgrade may be reduced to a minimum. On sections on which the sub-grade and shoulder materials are composed of types of soils that are conducive to pumping, measures to prevent pumping, such as the sealing of joints, care of surface drainage, and attention to drainage problems, should be taken.

The complete waterproofing of joints and cracks by the use of bituminous fillers has never been accomplished. Therefore, constant attention to the maintenance of a seal will be necessary if pumping is to be prevented by this method.

The use of French or other type drains through the shoulders of the road and into the ditches has been reported as only partially successful in stopping active pumping. The use of them cannot be recommended except as a temporary preventive measure.

It has been observed that new shoulders sloped to drain storm water to the pavement instead of to the ditches, high shoulders on existing pavements or shoulders which are badly rutted, contribute to pumping. Therefore, the maintenance of smooth shoulders sloping toward the ditch will help to eliminate pumping. (This seems obvious, but throughout the United States high and rutted shoulders on pavements are often overlooked.) Filling ruts and holes along the edges of pavements with pervious materials and the use of unsurfaced widening strips composed of pervious materials may divert the flow of water toward the pavement. These conditions contribute to pumping and such measures should be avoided in maintenance operations. All ruts, holes and trenches for widening materials should be filled with impervious material and sloped toward the ditch.

Correction

In Case 2 the most successful method of treatment consists in forcing a suitable mixture under the slab. Several commonly used mixtures for this purpose are described later in the report. This procedure forces water out from under the slab and fills the void between the subgrade and the slab. Settled slabs may also be brought back to proper elevation by continuing the operation.

The materials, equipment and procedures described hereafter are typical of those used by several States in the filling of void spaces under pavement slabs by means of the mud jack.

MATERIALS

Soils

The type of soil used in mud jack mixtures must necessarily vary with the location in which the work is being done. There are, however, some soil characteristics which will make mud jacking more efficient. A suitable soil must be of such character that it will slake readily in water to form a mixture of uniform consistency and shall be reasonably free of organic material. It must be reasonably free from glue-like colloids which do not soften readily when mixed with water and are productive of objectionable packing of the mixture in the mud jack. One State reports that soil having low shrinkage and a small quantity of colloidal clay gives the best combination. The clay adds to the workability of the mix and keeps the coarse particles in suspension.

Mixtures

The kinds of mixtures and the proportions of soils and admixtures used in various States differ. All States reporting indicate satisfactory results with the mixture they use. The mixtures and the methods of preparation used by several States are presented here for information. The term "slurry" used in the following descriptions and elsewhere in the report refers to the soil-water-admixture combination having the consistency required for use in the mud jack.

Illinois

The slurry shall consist of a mixture of cement limestone dust, slow curing liquid asphalt, soil and water. The percentage of these ingredients by volume, exclusive of water, are approximately as follows:—

Material	Per cent.
Cement	11
Limestone dust .. .	11
Slow curing liquid asphalt (SC-2 grade)	19
Soil	59
Total	100

or, in terms of parts by volume:

Cement	1 part
Limestone dust	1 part
Slow curing liquid asphalt (SC-2 grade)	1·75 parts
Soil	5·5 parts

Note.—Due to the fact that slow-curing (SC) liquid asphalts are now unobtainable, it is suggested by V. L. Glover, Engineer of Materials, Illinois State Highway Department, that the following grade of medium curing liquid asphalt be substituted.

Asphalt. MC-1. This material shall be a medium-curing cut-back asphalt consisting of a petroleum residuum fluxed with a suitable distillate. It shall be free from water, show no separation on standing and shall conform to the following requirements:

(a) Flash point (Tag open cup), not less than .. 100°F.

(b) Viscosity, Saybolt Furol, at 122°F, seconds .. 75 to 150*

(c) Distillation test:
Distillate, per cent. by volume of total distillate to 680°F:
Distillate to 437°F, not more than 20
Distillate to 500°F .. 25 to 65
Distillate to 600°F .. 70 to 90
Residue from distillation to 680°F per cent. volume by difference, not less than .. 60

(d) Characteristics of residue from distillation test.
(1) Penetration at 77°F, 100 g, 5 sec .. 150 to 300
(2) Ductility at 77°F (when the penetration at 77°F is between 150 and 200) not less than .. 100 cm
(3) Ductility in centimetres at 39·2°F, rate ½ cm per minute not less than 1/10 of the penetration at 77°F.
(4) Bitumen soluble in carbon disulphide, not less than .. 99·5%
(5) Spot test .. .. Negative.

The amount of water used shall be varied in accordance with the moisture content of the soil and the consistency desired Generally, 3·25 parts of water will be sufficient

Silty clay or clay loam top soils are the most suitable The clay adds workability; the sand reduces the shrinkage and increases the stability of the mixture, the oil is the waterproofing agent, the cement increases stability, helps to absorb the water, reduces the shrinkage, and accelerates set; the limestone dust accomplishes the same purposes as the cement although to a lesser degree, reduces the amount of cement required, and aids in holding the oil in the mixture

A small trial batch should be made to determine the amount of water required to produce the proper consistency, and also to determine the amount of cement and limestone dust needed to obtain the necessary initial set and stability. The amounts of these three ingredients will vary with the type of soil used and the purpose for which the mixture is to be used, that is, whether it is to be used for lifting the slab back to grade or filling the voids under the slab caused by the pumping action

In preparing the mixture, part of the water and the soil should be mixed first, then the liquid asphalt added, and finally the cement, limestone dust and such additional water as may be needed for the proper consistency and to accomplish the purpose for which the mixture is to be used.

Kansas

The mixture used is made by combining 8 parts by volume of cement, 5 to 8 parts of MC-2 or MC-3 cutback asphalt and 84 to 87 parts of soil with sufficient water to produce a consistency about like very thick buttermilk The mixing is done in a small concrete mixer

* The viscosity used should be from 100 to 150

Missouri

When mud jack work for the prevention of the pumping action was started in 1937, 1½ bags of cement per cubic yard of earth were used. For recent work more satisfactory results have been obtained with a mixture containing 4 bags of cement per cubic yard of soil.

Ohio

On one project Ohio reports the following —

During November and December of last year the French drains were supplemented by pavement jacking at all joints where pumping was observed. Various mix proportions were used, and all of the mixes substantially reduced the amount of pumping

Mix 1 consisted of 50 per cent SC-2 and 50 per cent, powdered asphalt by weight. For the weather conditions at the time this work was done a temperature of about 250 degrees F. was necessary.

Mix 2 consisted of soil, powdered asphalt and SC-3. This material has extruded from the joints and cracked the pavement badly

Mix 3 consisted of 67 per cent. soil, 25 per cent. SC-3, 4·5 per cent. cement and 3·5 per cent powdered asphalt by weight with sufficient water to make the mixture workable in the mud jack This was the first mix to be tried, and it was gradually changed by lowering the percentage of soil, cement and water until mix 1 was attained. Mix 2 was essentially a stage in this transition.

Study of the performance of the various treatments used indicates that the mixture of SC-2 and powdered asphalt alone has given the most satisfactory results However, all of the mixes tried have resulted in considerable improvement of the pavement when compared to its condition in the fall of 1941

Note:—In view of the fact that slow curing (SC) liquid asphalts are now unobtainable, Mr Charles W. Allen, Acting Chief Engineer, Bureau of Tests, Ohio State Department of Highways, reports that Ohio intends to experiment with the lighter consistency medium curing (MC) liquid asphalts and road tars.

Admixtures

The reports received indicate that the choice of an admixture for use with soil is a matter to be left to the judgment of the engineer. The quantity of cement used varies from 0 to 5 bags per cubic yard. The bituminous material, where used, may be slow curing asphaltic oil or medium curing cutback asphalt and the quantity varies from 8 to 25 per cent. by volume.

The final mixture of soil and cement or soil bituminous material and cement must have low shrinkage when dried and must flow at a relatively heavy consistency.

Testing Soil and Soil-Mixtures

Laboratory tests should be utilised to measure the shrinkage and hardening characteristics of the soil and soil-mixtures In an emergency and as a routine field test, the shrinkage may be judged by mixing a properly proportioned batch of the materials to the consistency desired by the mud jack operator and moulding parts of the mixture in the top of ice-cream cartons or other flat containers and drying in the sun or any other available heat source. The entire absence of shrinkage or the occurrence of a very small amount of shrinkage will indicate a satisfactory mixture. Appreciable shrinkage will indicate the necessity for a change in soil or the use of an additional quantity of admixture.

Hardening may be judged by means of similar samples buried at the edge of the slab for 24 hours.

Recommended Field Procedures

The following procedure is typical of that being followed by most States and is recommended by the Committee Such variations as local conditions may require are desirable and permissible

Drilling

For the expulsion of water and for filling the voids under the slab a hole is drilled near the intersection of the transverse joint or crack with the centre joint The location of each hole should be approximately 10 in. from the centre joint and 10 in. from the transverse joint or crack (Fig 1). The hole should be located on the far side of the transverse joint or crack in the direction of traffic.

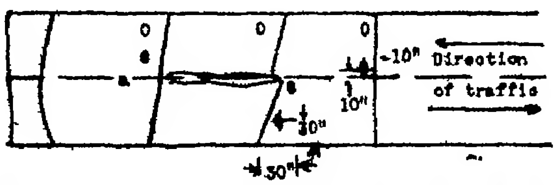


Fig. 1. Typical location of void filling and lifting holes at transverse joints and cracks C, void filling hole : O lifting hole.

When the pumping action has caused settlement of the slab and it is desired to lift it back to grade, holes should be drilled 30 in. each way from the intersection of the transverse crack or joint with the outside edge of the slab (Fig. 1).

The location of both the void filling holes and the lifting holes shown in Figure 1 are for average conditions. Other positions of the holes may be desirable under some field conditions. In the case of 4-lane pavements, settlement almost always occurs in the outside lane which carries the bulk of the heavy traffic. The inside or passing lane seldom settles.

Filling Void Spaces

The first step in the void filling

(Continued on page 56.)

GRADING CONCRETE AGGREGATES

IF concrete is to be strong, water-tight, and durable it must be dense; that is, free from voids. A heap of stones all of one size would be only about half stone, the rest being pockets of air between the stones The cheapest material with which to fill these voids is more stones, but obviously they must be smaller than the largest stones and there must be smaller and still smaller particles to fill the spaces between all the sizes larger than the smallest. This proportioning of the different sizes of particles of aggregate from the largest to the smallest is known as "grading," and the more carefully an aggregate is graded the stronger a concrete will be if all the other processes are the same.

The principles of grading are demonstrated diagrammatically in *Figs* 1 to 3. In *Fig* 1 the stones are all of one size, and there is a large proportion of voids. In *Fig* 2 there are two sizes of stone and in *Fig*. 3 three sizes, and it will be seen that the voids are progressively reduced. Pieces of aggregate are of course, of irregular shape, and these diagrams are intended to show the principle only. *Fig* 4 shows a concrete mix that is deficient in the smaller sizes of stone, and it can be seen that when this concrete is set and hard it will have a high proportion of voids A section cut through concrete made with a properly graded aggregate is shown *in Fig* 5, where it is seen that pieces of aggregate of different sizes are more or less evenly distributed and, when they are coated with a thin film of mortar, make a dense concrete

It might be thought that sand could be used to fill the spaces between large pieces of gravel, but this would result in a less dense and weaker concrete, unless it were very rich in cement, due to the extra surface area of small particles compared with an equal volume of larger particles An example will make this clear

SURFACE AREA OF AGGREGATES — Consider a cube with 12-in sides (*Fig* 6) and the divisions shown in *Fig* 7.

If this cube were divided into eight (*Fig* 7) there would be eight cubes with 6-in. sides Each side has a surface area of 6 in by 6 in. = 36 sq in. Each cube, having six sides, will therefore have a total surface area of 36 sq in. × 6 = 216 sq. in, and the total area of the surfaces of the eight cubes would be 216 × 8 = 1,728 sq in

Now divide the 12-in. cube into 1-in. cubes. This will give 12 × 12 × 12 = 1,728 cubes, each measuring 1 in by 1 in. by 1 in. Each side has an area of 1 sq. in., so that each cube, having six sides, has a surface area of 6 sq. in. The total surface area of the 1,728 1-in cubes is therefore 6 sq. in. × 1,728 = 10,368 sq. in.

Thus the same volume of 1-in. cubes has a surface area six times as great as an equal volume of 6-in. cubes, and this means that six times as much cement would be necessary to coat the smaller pieces with the same thickness of cement paste. The example demonstrates the reason for the low strength of mortar made with fine sand unless it is very rich in cement

COARSE AND FINE AGGREGATES.—The ideal aggregate is one comprising all sizes from the largest to the smallest in the proportions that produce the greatest density, and it is found in practice that this can best be obtained by dividing the aggregate into two sizes, the coarse and the fine.

Coarse aggregate is all the material that is retained on a sieve with $\frac{3}{16}$-in. holes Fine aggregate is the material that will pass through a $\frac{3}{16}$-in sieve, with any excess of dust removed If the coarse and fine aggregates are both properly graded, that is if they contain different size particles in such proportions that each is of the greatest possible density, then a suitable aggregate is produced by mixing them together in the proportions of two parts of the coarse aggregate to one part of the fine aggregate

SAMPLING AGGREGATES —To ascertain the grading of an aggregate by the use of different size sieves as discussed in the following it is necessary that the sample to be tested should be truly representative of the material. In the case of coarse or "all-in" aggregate it is common to test a sample weighing about 20 lb. For fine aggregate a smaller sample weighing about 3 lb is sufficient The best way to get a representative sample is as follows.

Coarse and "All-in" Aggregate — Spread out about 100 lb of the material and divide it into four parts as nearly equal as possible. Discard two of the quarters, and remix and spread out the remaining two quarters Again divide the material into four parts as nearly equal as possible, discard two of the parts, and remix the remaining two parts, which will weigh about 25 lb From this weigh out 20 lb for sampling

Fine Aggregate —Spread out 50 lb of the material, and continue quartering and remixing three times, as before, until about 3 lb. are left, and from this weigh out 50 ounces for sampling

SIEVE SIZES —It is important that standard sieves should be used for grading aggregates, as mesh sizes mentioned in specifications generally refer to standard sieves It must be borne in mind that a ¼-in mesh is not the same as 4 meshes to a linear inch, because

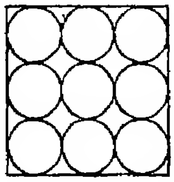


Fig I.

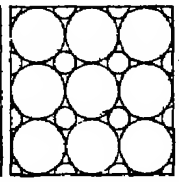


Fig. 2.

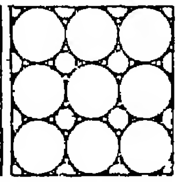


Fig. 3.

Fig. 4.—A Badly Graded Concrete with Insufficient Fine Material.

Fig. 5.—Concrete made with Well Graded Aggregate.

the latter will have smaller openings due to the space occupied by the wires The British Standard Test Sieves, with the corresponding dimensions of the openings in decimals and fractions of an inch, are given in *Table* III.

TABLE III—STANDARD SIEVES

Sieve Size or Number.	Nominal Size of Aperture (in)	Nearest Fractional Equivalent (in).
1½ in.	1½	1½
¾ ,,	¾	¾
⅜ ,,	⅜	⅜
3/16 ,,	3/16	3/16
No 7	0 0949	1/10
,, 14	0 0474	1/21
,, 25	0 0236	1/42
,, 52	0 0116	1/84
,, 100	0 0060	1/166

Nests of these standard sieves (*Fig.* 8) are obtainable from suppliers of concrete testing apparatus They are arranged to nest inside one another, with the coarsest sieve at the top and the finest at the bottom, so that the sample can be put in the top sieve, the frame shaken, and the amounts left on each sieve weighed *Figs* 9 and 10 show various sizes of coarse and fine aggregate retained on different sieves

For most work, however, fewer sieves can be used In the following gradings it is assumed that the samples used weigh 20 lb in the case of coarse and "all-in" aggregate and 50 oz in the case of fine aggregate The quantities that should pass through or be retained on the various sieves are given in pounds and ounces, and also in percentages of the weight of the total sample If samples of different weight are tested, the percentages may be used.

GRADING COARSE AGGREGATE.—For most practical purposes a coarse aggregate of ¾-in. maximum size is suitably graded if a 20-lb. sample passes the following test.

Not more than 2 lb (10 per cent.) should pass through a sieve with 3/16-in. meshes

Not more than 12 lb. (60 per cent.) and not less than 5 lb (25 per cent.) should pass ⅜ in.

Not more than 1 lb. (5 per cent.) should be retained on a ¾-in. sieve, and these stones should not greatly exceed the ¾-in. dimension.

A grading recommended by the Institution of Structural Engineers for aggregate of ¾-in. maximum size is as follows (20-lb sample).

None must pass 3/16 in
4 lb (20 per cent.) must pass ¼ in.
8 lb (40 per cent) must pass ⅜ in.
12 lb (60 per cent) must pass ½ in.
16 lb (80 per cent.) must pass ⅝ in

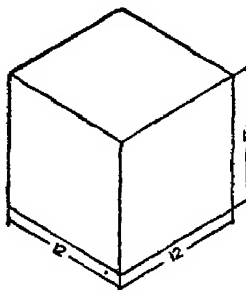


Fig. 6.

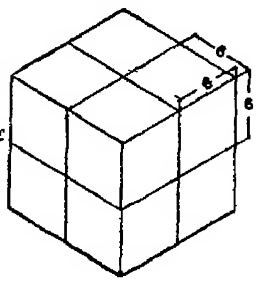


Fig. 7.

20 lb (100 per cent) must pass ¾ in.

British Standard Specification gradings for coarse aggregates of three different sizes are as follows.

1½-in. maximum size (20-lb. sample)—

Not more than 1 lb. (5 per cent.) to pass 3/16 in.

Not less than 2 lb. (10 per cent.) to pass ⅜ in. and be retained on 3/16 in.

Not more than 16 lb (80 per cent) or less than 10 lb (50 per cent.) to pass 1½ in. and be retained on ¾ in.

Not more than 1 lb. (5 per cent.) to be retained on 1½ in.

¾-in. maximum size (20-lb. sample)—

Not more than 1 lb. (5 per cent.) to pass 3/16 in.

Not less than 4 lb. (20 per cent.) to pass ⅜ in. and be retained on 3/16 in.

Not more than 14 lb. (70 per cent.) or less than 10 lb (50 per cent.) to pass ¾ in. and be retained on ⅜ in.

Not more than 1 lb. (5 per cent.) to be retained on ¾ in.

⅜-in. maximum size (20-lb. sample)—

Not more than 1 lb (5 per cent.) to pass 1/16 in.

Not less than 18 lb (90 per cent). to pass ⅜ in and be retained on 1/8 in.

Not more than 1 lb. (5 per cent) to be retained on ⅜ in.

GRADING FINE AGGREGATE.—A grading of fine aggregate that will be acceptable for most concrete work is as follows, using a sample weighing 50 ounces.

Not more than 25 oz. (50 per cent.) or less than 15 oz. (30 per cent) to pass 1/32 in

Not more than 30 oz. (60 per cent) or less than 20 oz (40 per cent.) to pass 1/16 in.

Not more than 45 oz. (90 per cent) or less than 35 oz (70 per cent.) to pass ⅛ in

Not less than 48 oz. (96 per cent.) to pass 3/16 in.

The British Standard Specification for grading fine aggregate is as follows (50-oz. sample).

Not more than 5 oz. (10 per cent.) to pass No. 100 sieve.

Not more than 15 oz. (30 per cent.)

Fig. 9.—Two Sizes Sieved out from a Sample of Coarse Aggregate.

Fig. 10.—Three Sizes Sieved out from a Sample of Fine Aggregate.

Fig 8.—Sieves for Grading Aggregates.

or less than $2\frac{1}{2}$ oz. (5 per cent.) to pass No. 50 sieve.

Not less than $2\frac{1}{2}$ oz. (5 per cent.) to pass No. 32 sieve.

Not less than $2\frac{1}{2}$ oz. (5 per cent.) to pass No. 14 sieve.

Not less than 35 oz. (70 per cent.) to pass No. 7 sieve.

Not less than $47\frac{1}{2}$ oz. (95 per cent.) to pass a $\frac{3}{16}$-in. sieve.

The Institution of Structural Engineers recommends the following grading for fine aggregate (50-oz. sample).

None must pass 1/75 in.

10 oz. (20 per cent.) must pass 1/50 in.
20 oz. (40 per cent.) must pass $\frac{1}{32}$ in.
30 oz. (60 per cent.) must pass $\frac{1}{16}$ in.
40 oz. (80 per cent.) must pass $\frac{1}{8}$ in.
50 oz (100 per cent.) must pass $\frac{3}{16}$ in.

[It will be noted that the smaller sieves used in this analysis are not the standard sizes given in *Table* III.]

GRADING "ALL-IN" AGGREGATE.—The British Standard Specification of 1940 recommends the following gradings for $1\frac{1}{2}$-in. and $\frac{3}{4}$-in. "all-in" aggregate, that is an aggregate that has not been separated into coarse and fine, but which is delivered as a complete aggregate containing all sizes from the largest to the smallest.

$1\frac{1}{2}$-in maximum size (50-lb sample)—

Not more than 5 lb. (10 per cent) to pass No 100 sieve.

Not less than 10 lb (20 per cent.) or more than 20 lb (40 per cent.) to pass $\frac{3}{16}$ in. and be retained on No 100 sieve.

Not less than 25 lb. (50 per cent) or more than $37\frac{1}{2}$ lb (75 per cent) to pass $1\frac{1}{2}$ in. and be retained on $\frac{3}{16}$ in

Not more than $2\frac{1}{2}$ lb. (5 per cent) to be retained on $1\frac{1}{2}$ in.

$\frac{3}{4}$-in. maximum size (50-lb sample)—

Not more than 5 lb. (10 per cent) to pass No 100 sieve.

Not less than 15 lb. (30 per cent) or more than 25 lb. (50 per cent) to pass $\frac{3}{16}$ in and be retained on No 100 sieve.

Not less than 20 lb (40 per cent) or more than 30 lb (60 per cent.) to pass $\frac{3}{8}$ in and be retained on $\frac{3}{16}$ in

Not more than $2\frac{1}{2}$ (5 per cent) to be retained on $\frac{3}{4}$ in

If the analysis shows that there is too much or too little of any particular size or sizes, then some of the surplus must be screened out or more of other sizes added until the grading requirements are met.—(*With acknowledgments to "Concrete Building & Concrete Products."*)

PUMPING OF CONCRETE SLABS

—(*Continued from page 53*)

operation is to force all trapped water from under the slab by means of compressed air. This is necessary in order to avoid dilution of the soil mixture with water and to insure the filling of the void space. To allow the escape of water, each transverse joint should be vented at the outside edge of the pavement by digging away the shoulder material.

Where there is evidence of considerable water under the slab, it is sometimes necessary to strip short sections of the bituminous filler from the joints to allow free escape of the water.

After the water has been forced out, the slurry is pumped into the voids until it appears in the cracks and in the vents at the edge of the pavement. In some cases, it is advisable to admit shots of air between shots of slurry in order to force the mix the maximum possible distance.

When the slab is not to be lifted, pumping is stopped when the slurry appears at cracks, joints or the edges of the pavement or when the slab starts to lift. In lifting slabs, the vents at the edges of the pavement are closed by filling with dirt, and, if necessary, wooden plugs are driven into adjacent holes and clay is tamped into leaky joints Slurry is then pumped in the lifting hole until the slab is raised to the desired elevation.

After all the void filling and lifting operations have been completed, the holes are sealed with clay Later the holes should be cleaned out and sealed with bituminous filler

The successful filling of void spaces under concrete pavements or the lifting of depressed slab ends to their original elevation by means of the mud jack requires careful engineering supervision and skilful operation of equipment It is the opinion of the Committee that the entire attention of one experienced engineer will be required during the operation of each mud jack unit, and that operators of equipment should be carefully trained before being assigned to work on heavily travelled roads The use of the mud jack without adequate supervision or with inexperienced operators is likely to result in failure to stop pumping at slab ends and may result in damage to the pavement.

Equipment

For ordinary operations, the standard mud-jacking equipment, which most of the highway departments already have may be used for this work

This consists of :—

No 50 mud jack
$2\frac{1}{2}$ in. mud jack bit.
Air compressor
28 to 35 lb jack hammer

—(*With acknowledgments to "Constructional Review"*)

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